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# Delicious Foods Are Baked in Cast Iron Dishes

GEE, Mom, that's good," says Jim when he comes home from play. "Gimme su'more." Mother smiles for, although she knows she can cook well, she likes to be told about it. "Yes, it is good, and I baked it in that new cast iron dish we bought yesterday." To Jim, dishes are dishes,

*Courtesy Ferro Enamel Corp.*
*Cast Enameled Dishes Have Utility and Beauty*

but Mother has her preferences. She liked the color of these new cast dishes when she first saw them at the store, and had a difficult time deciding whether she liked the green, blue, rose or yellow the best. She finally decided to buy the color which would match her dishes. These new dishes also had other advantages, she thought. Food could be cooked in the cast dishes directly over the flame or in the oven and then could be placed on the table without transfer to another dish. They also looked fine on the table. They bake uniformly, for since they are made of cast iron and are heavily coated with enamel, they retain and distribute the heat evenly. A cast iron tray also is supplied with each dish to protect the table from the heat. Yes, Mother is satisfied with her new dishes and the foundry industry has added another item to its long list of household products.

**Find Where Castings Can Be Sold**

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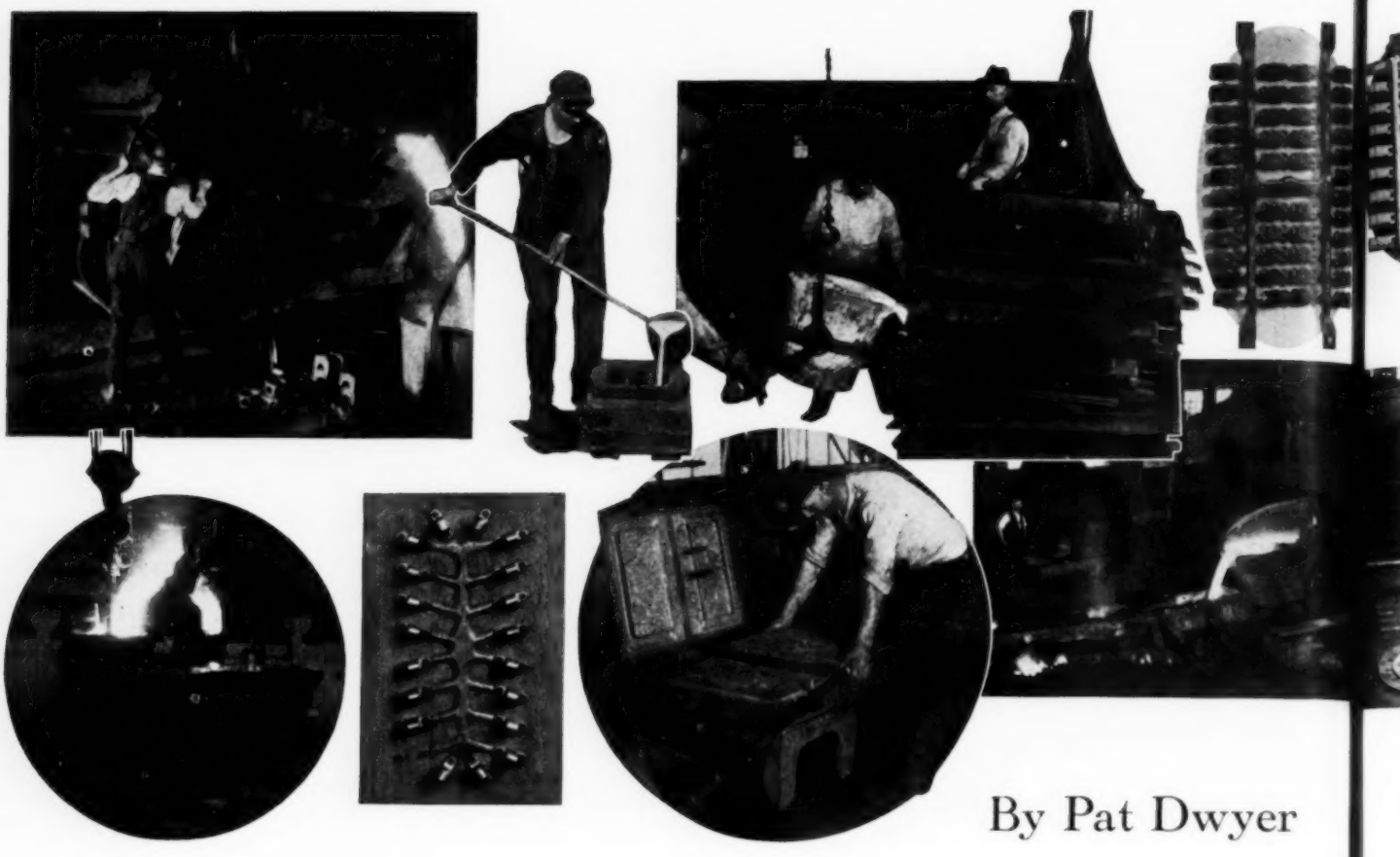


By Pat Dwyer

# Prevent Losses with

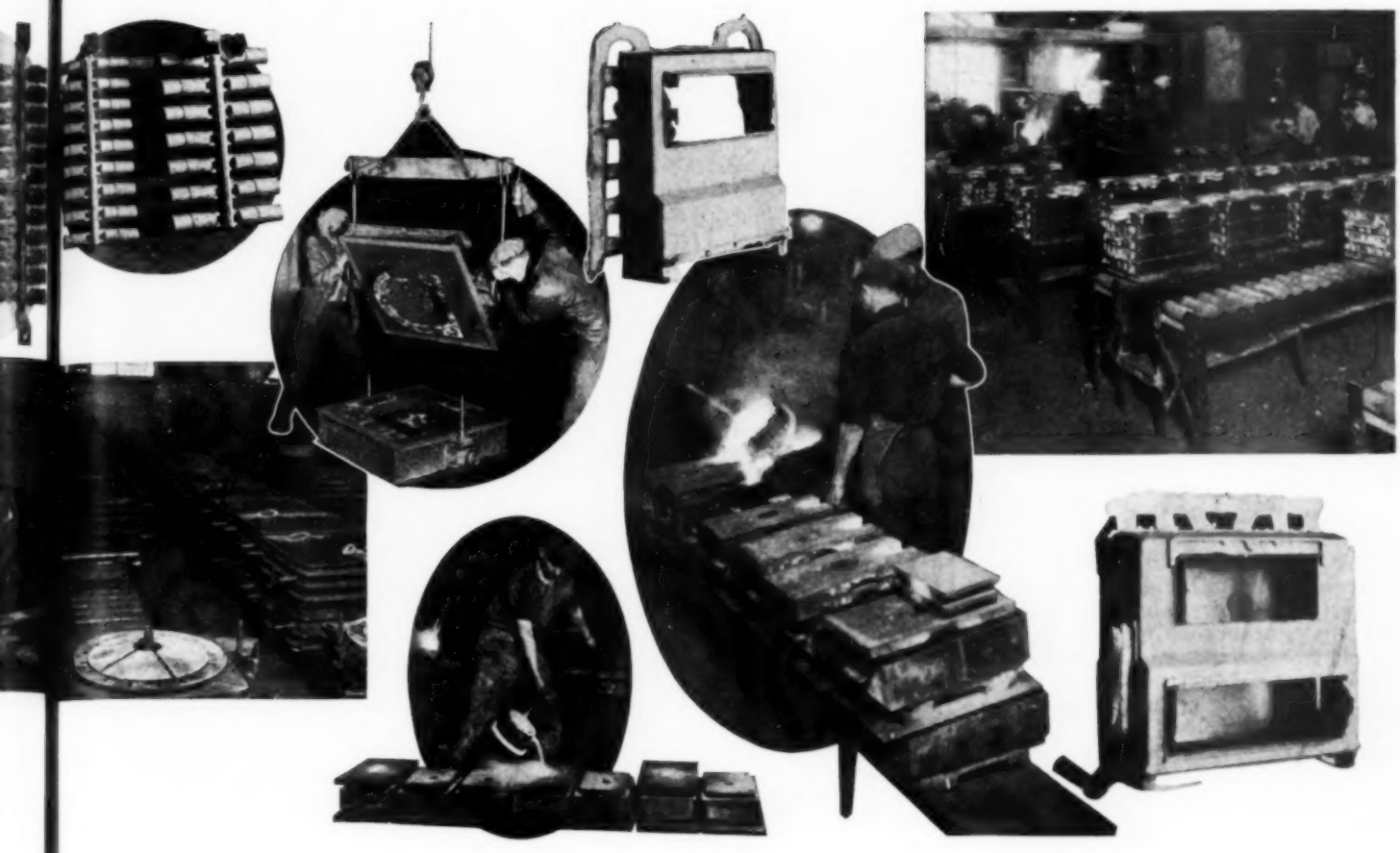
FUNDAMENTALLY, the production of a casting is a simple process, well within the capability of any ordinarily intelligent person. A pattern conforming to the shape of the desired casting is placed in a flask, a simple container made of wood or metal. The pattern is surrounded with packed sand, withdrawn, and then the resulting cavity is filled with molten metal which upon solidifying assumes the shape of the pattern.

Apparently nothing could be more simple and yet, as a matter of fact, the successful production of castings represents highly specialized effort. A multiplicity of detail enters into the process. Many factors are involved. Unless every detail is observed faithfully and unless every factor co-ordinates in orderly sequence with the others, the casting will not serve the purpose for which it was designed. The feature which more nearly affects the foundryman is that the casting will not be accepted by the customer and merely represents its value in scrap metal.

Castings are lost day by day, not through any obscure metallurgical cause, but simply through lack of a little practical knowledge on such points as gating, pouring, risers, shrink heads and suitable pressure for either light or heavy castings. Notwithstanding all the literature presented on foundry subjects this lack of fundamental knowledge still is responsible for a great number of defective castings.

Out of 50 lost castings selected from a long list by J. A. Murphy, the accompanying tabulation shows that only three could be laid at the metallurgical door. Approximately 86 per cent of the defective castings were due to slovenly molding practice and dirty molds, to gates that neither were designed nor cut properly, and to a promiscuous and unintelligent use of risers and shrink heads.

Usually where certain areas in a casting are dirty, the only question involved is where did this dirt come from? The remedy obviously is to adopt a method that will prevent small or large portions of sand from floating around promiscuously in the mold. Common sense investigation will show that the dirt originated



# Proper Gates and Risers

in a scab on the face of the mold or core, a cut runner or loose sand washed in from the pouring basin. In some cases the dirty areas plainly are due to slag, poured in with the metal through a huge gate.

Many foundries never produce perfectly clean engine cylinders, or for that matter, perfectly clean castings of any kind. The iron or the coke or both are blamed when in reality the defective castings are due to faulty gating methods or other details of the molding process.

In one extreme instance quoted by Mr. Murphy where the foundry could not produce a cylinder casting that would bore out clean, the executive in charge decided to change the size of all the cylinder patterns. He reasoned that by making the bore larger, he could fit the cylinders with liners and his troubles would be over. To his extreme surprise he found that the liners, if anything, were dirtier than the cylinders.

Later the molding practice was changed slightly and the liners were cast successfully in open sand molds. They were poured from the bottom and a little excess metal was provided on the top for cleaning purposes.

Ring castings apparently are plain and simple, but in reality they are extremely difficult to produce unless certain precautions are observed. Where these castings are poured in closed molds, risers are not required to permit the escape of occluded gas. The ordinary shrink head is useless and unnecessary, and may be the cause of direct injury to the casting.

The method adopted for pouring the iron, whether from the top or the bottom, has no effect on the soundness or cleanliness of the resulting casting. Perfectly clean castings are secured by pouring the iron through a multiplicity of small pop gates on the top. Equally clean castings result when the iron is poured through one or more long, narrow gates near the bottom. Usually top pouring is confined to large rings, while the bottom gates are favored for smaller castings. This distinction is made through expediency and in deference to mechanical and operating features and not even remotely because it may affect the release or

retention of occluded gas in the metal. A small, show-up riser may or may not serve a useful purpose, this depends on local custom.

Broad assertions that risers and shrink heads are necessary or unnecessary, must be accepted with some reservation. Because some few relatively unimportant castings have been produced successfully by any particular process is not sufficient to prove the foundry millennium has arrived.

Risers are used for several purposes. For example, they indicate when a mold is full or nearly full. Pouring may cease at the first point, or, it may be continued until a definite amount of metal has flowed through. In the second case, pouring ceases temporarily, shortly after the metal first appears in the bottom of the riser. The mold then is *touched up* a few times by pouring additional metal in small quantities until the risers are filled to the desired height.

Practical foundrymen strongly favor the touching up process. To quote from standard tradition, it takes out the wrinkles. Many a casting prone to kicking during the pouring process has been saved in this manner. Others will be saved, probably for a long time to come, by this excellent and practical safety first measure.

Under certain circumstances, a shrink head will promote a shrinkage cavity rather than prevent it. On cylindrical castings which require some form of feeding, it is preferable to extend the entire end of the cylinder upward rather than attempt to feed the ring through one or more shrink heads. Unless the ring is carried to a proper height it will defeat its own object.

Many features of prime importance in the successful production of large castings enter but little and in some cases not at all, into the production of light castings. For example, the shape and size of the gate and the position where it is attached to the casting usually are of little moment. However, in nearly all cases it is necessary to provide a safety device at a point between the runner basin and the mold to prevent any dirt from floating in with the metal.

No standard rule can be laid down on this point. Almost every casting is a problem in itself. Before the pattern is taken to the molder the position of the gates, risers and other features should be determined if possible by a foundryman of wide judgment and experience. The day when the average molder could be trusted to decide these points for himself has passed.

Wherever possible a competent experimental molder should study and devise the most suitable method of gating and heading each casting. When the desired method of molding has been worked out, the job can be put into production. Many foundrymen have had this idea, but too often, particularly in jobbing shops, the patterns are turned over to a molder with instructions to put up so many flasks. He is given no detailed advice on gating or heading. Jobs are put into production before the difficulties are apparent. With many castings it is impossible to determine in advance where the difficulties lie, and lack of attention to this detail is the cause of many waster castings. If the molding method is worked out before the job is put into production, necessary corrections can be made after each experimental casting is poured. When the job has been launched successfully, notes may be made and a good casting can be photographed with the gates and risers attached so that a permanent record will be available. Experimental molding is not necessary for every job that is brought to the shop. Molders and foreman come and go, therefore a permanent record showing the proper method of molding, gating, heading, position of chills, and so on, would be invaluable.

A typical case of porosity under a riser is shown in Fig. 2. The riser as first applied is shown at *A*. Later the riser was reamed out as it appears at *B*, but the net result was a porous spot worse the second time than it was at first, even though a feeding rod was applied. The trouble

## Specialist Needed

*ARRANGEMENT of patterns and disposition of the gate or gates should be decided by a person qualified for the service through study and experience. In some instances the size, shape and position of the gate, are not factors of major importance. In other instances, probably the majority, they are of the utmost importance and permit of practically no deviation, if castings are to be kept out of the scrap pile. Interesting results are claimed for a system of small gates and slow pouring by which the metal at high temperature is introduced to the mold through gates much smaller than those sanctioned by ordinary usage.*

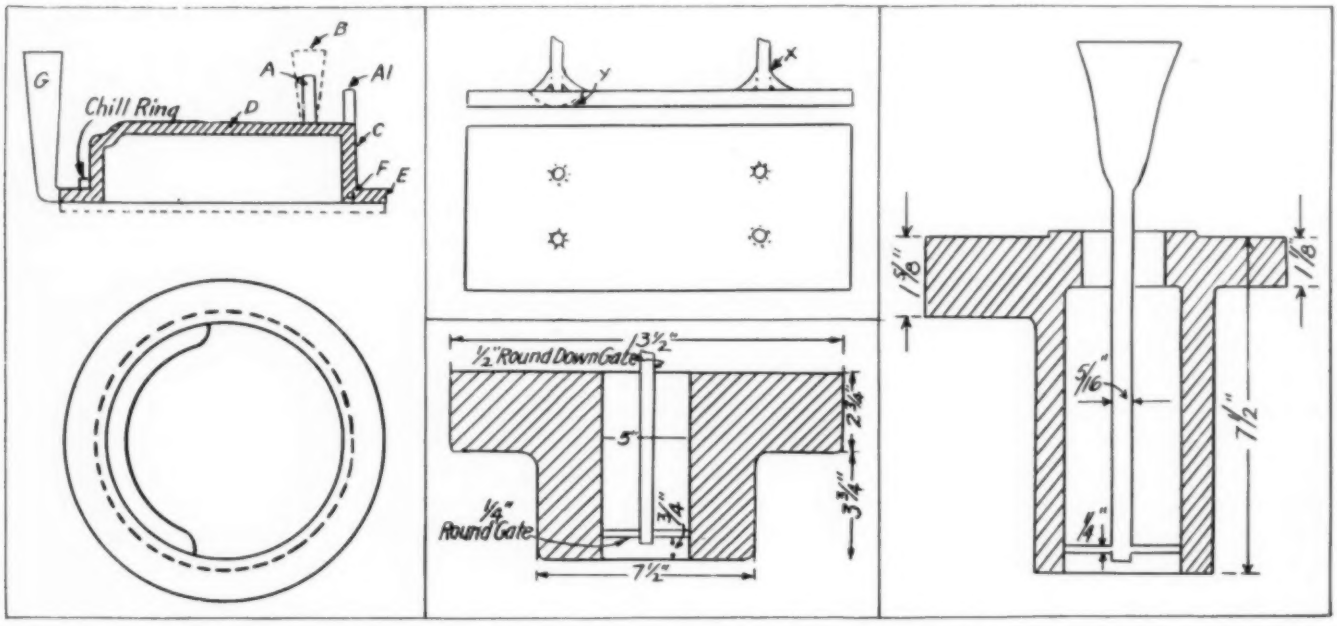



*Fig. 2—(Left)—Risers Shown Here Were of No Value. Fig. 3—(Above, Center)—Another Unnecessary and Harmful Type of Riser. Fig. 4—(Center, Below)—Shaft Coupling Poured Through Two Small Horizontal Gates Near the Bottom. Fig. 5—(Right)—Extra Precaution Must Be Observed in Venting Cores of This Type*

disappeared when the riser was moved to the edge *A*1. A safer precaution would have been to remove it altogether. Then the risk would have been removed of a careless molder ramming it back in over the flat face of the casting.

Some months later this casting again caused trouble. An investigation disclosed an entirely new set of conditions. The lower flange *E* had been thickened as shown by the dotted line and segregation had developed at several points around the ring *F* at the junction of the flange with the vertical wall *C*.

Four large side feeders *G* had been tried in an attempt to stop the segregation, but apparently they had no effect. Plainly the trouble was caused by the difference in thickness between the flange and the wall which caused the metal in these two parts to cool at different speeds. Several remedial measures were proposed, including the use of a chill ring or a redesign of the pattern. In this instance the chill ring method was adopted.

### Design Is Defective

That usually is the manner in which foundry problems are solved. Designers notoriously are unwilling to admit that they are responsible for defective castings and the foundryman is compelled to go on for some time making wasters, before the order finally is issued to increase or decrease the thickness of the pattern at certain points. In self defense, the foundryman sometimes adopts a temporary measure, such as the chill described in the preceding paragraph. The proper course to pursue would be to insist on increasing the thickness of the vertical wall of the casting.

Pressure is an important factor in securing solid castings. The proof may be seen in the numerous holes on the upper face of any plate cast in an open sand mold. Where the iron is poured hot the holes are small and where the iron is dull the holes are larger. Hot or cold, large or small, they always are there. It may be claimed they are caused by absorbed gases rising from the boiling face of the mold. This hypothesis is knocked out by the well known fact that they are found in castings poured in perfect molds where no boiling action took place.

An example of the commonest form of useless riser is shown in Fig. 3. Usually only one or two risers are placed on a casting. This extreme instance of four risers on a 2½ x 4-foot plain plate may be cataloged as a modern as well as an ancient source of trouble.

The manner in which the risers are attached and not the actual number employed is what constitutes the objectionable feature of the practice. The average molder is possessed with an insatiable desire to ream the edges of all gates and risers. Under certain conditions the practice is commendable rather than harmful. For example where the gate or riser is located in the sand at a distance from the actual mold cavity.

A riser reamed as in Fig. 3 will cause trouble when it is broken away from the casting. Either it will break a gap out of the face as shown at *Y* or it will break off at the neck *X* and leave a stump which has to be chipped away later at considerable expense.

Porous and spongy castings, in many cases, are caused by risers and shrink heads. Due to habit and lack of thought they are used to a far greater extent than necessary both on iron and steel castings.

E. V. Ronceray covered the same features in a paper presented several years ago, before the Institute of British Foundrymen. He showed that, to a great extent, risers are unnecessary and that slow pouring through small gates will produce solid castings.

With this understanding perhaps it will be appropriate to present a short description of a few samples of castings which have been made successfully by slow pouring and with no feeding heads.

Some trouble was experienced at first from scabbing with the castings shown in Figs. 4, 5, and 6 when proper sand was not used for the core. Similar results are obtained by Bru-

## Causes of 50 Defective Castings

MAJORITY DUE TO FAULTY MOLDING PRACTICE

| Direct Cause of Defect | Metallurgical | Molding |
|---|---|---|
| White hard spots due to low silicon and the use of wrought iron in the mixture | 1 | .... |
| High sulphur iron combined with use of high ash coke | 1 | .... |
| High phosphorus and high silicon | 1 | .... |
| Unsuitable and improperly prepared sand | .... | 6 |
| Slovenly molding | .... | 8 |
| Gates improperly designed and applied | .... | 14 |
| Unnecessary risers | .... | 9 |
| Unnecessary shrink heads | .... | 6 |
| Poor quality facing | .... | 1 |
| | 3 | 44 |
| Dull iron (This is an operating and not a metallurgical problem) | 3 | |

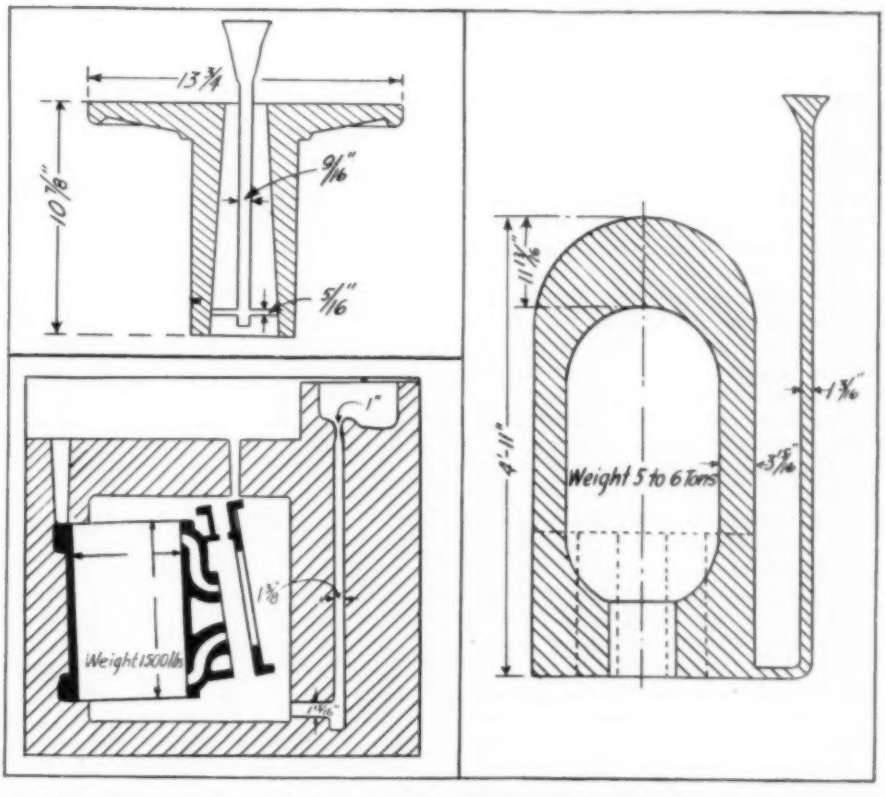



*Fig. 6—(Above, Left)—This Style of Gate Produced a Solid Casting. Fig. 7—(Lower Left)—A Choked Area Immediately Under the Pouring Basin Regulates the Pouring Speed. Fig. 8—(Right)—This Large Casting Was Poured Through a Single Small Gate at the Bottom*

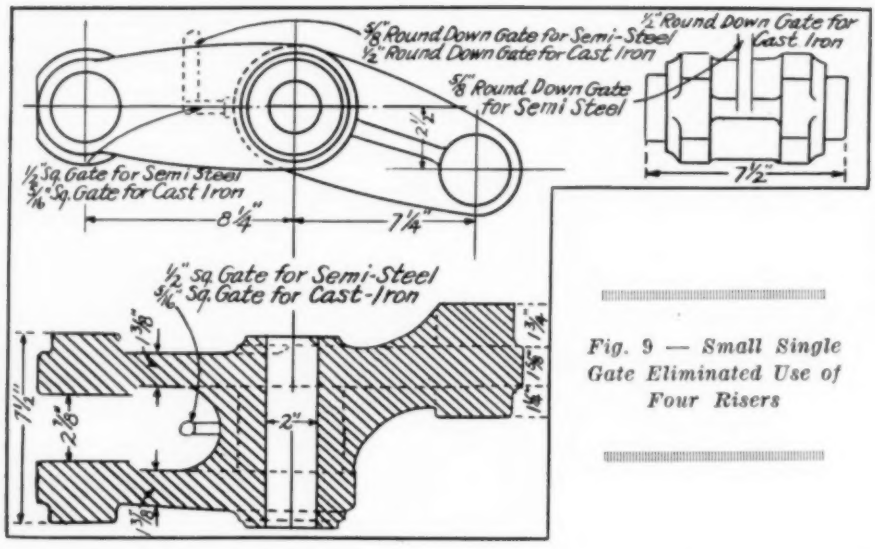



*Fig. 9 — Small Single Gate Eliminated Use of Four Risers*

nelli runners used on top of casting. This method will be described in a later number of the present series.

The top of the core shown in Fig. 5, heated inside and outside, evolved too much gas and produced a waster when the core was not perfectly vented. This casting now is poured on top with a single ¼-inch diameter runner.

Castings can be made without feeding heads under the following conditions: (a) where the gating and cooling can be arranged so that solidification takes place at the same time throughout the casting; (b) where there will be no swelling of the sand, or, if there is, it will not continue after pouring is completed.

Small runners involve the use of very hot metal. The runners must be kept filled during the pouring so that no air or slag enters the mold. Slag always must be kept out of molds if sound castings are expected. Numerous methods are available to obtain this result, if foundrymen only gave the question consideration.

Slow pouring has the additional advantage of giving more time for the gas to escape. Some foundrymen prefer to restrict the area of the gate at a distance from the mold and to increase the size of the runner close to it, to reduce the speed of metal entering the mold. This is quite reasonable, especially when the stream is striking a core or a projecting part of sand.

Fig. 7 refers to locomotive cylinders cast vertically at Cockerill Works, Seraing, near Liege, Belgium. It can be seen that the runner is choked close to the basin and that afterward the size of the runners is increased. Risers are provided to allow some iron to run through. Their section is too small to consider them as feeding heads. This practice is quite common in the Liege district.

Previous to adopting this system, an English firm was obliged to have a large riser over each of the bosses, also one on the body of the casting shown in Fig. 9. This meant four risers to be fed and afterward cut off by machine. The casting made under the new system was broken and found to be absolutely solid and without any signs of sinking on the outside. Another casting made from a semi-steel mixture with 35 per cent steel and with the gates slightly enlarged gave the same good results.

Another casting made by the same firm is shown in Fig. 4. It is a shaft coupling, weighing 112 pounds. The diameter of vertical is ½-inch and that of the two horizontal runners ¼-inch. It is said that previously this casting had to be fed to avoid porosity. No sign of sinking was found; broken, it was perfectly solid and even in texture, and the machine shop foreman claimed it was the cleanest casting he ever had to machine.

The hydraulic cylinder shown in Fig. 10 weighed about 10 tons and apparently had no feeding head. However, inquiry showed that the part of the casting where the gates were attached had to be cut off and that it was put there more as a safety factor than anything else. The 10 tons of iron were poured through 8 round gates ⅝-inch diameter.

Many reports of successful experiments have been received from different parts of Europe. No doubt other foundrymen will succeed in many cases if they try by themselves.

The underlying scientific principles are not dealt with in detail because the author is not certain that his hypotheses are right. For the present he is satisfied that it is possible by this method to pour successfully a great number of castings that formerly have been considered impossible to cast without feeders and to get them sounder than those poured with feeding heads.

Obviously it is desirable that scientists and practical men should try to determine causes for such results, which probably will result in the discovery of unknown laws.

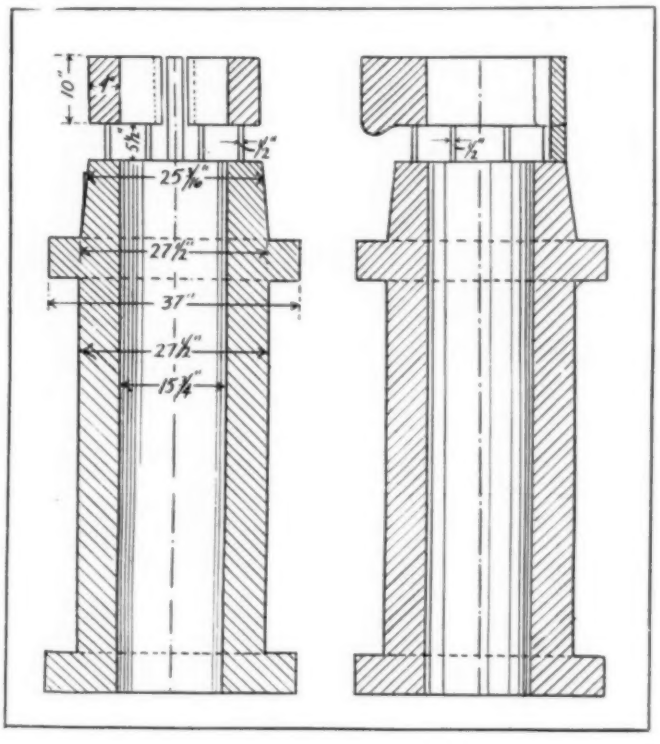



*Fig. 10 — Large Hydraulic Cylinder Poured from the Top*

## A Correction

Through an error, the business connection of Lester B. Knight, author of the article "Synthetic Molding Sand Requires Proper Base" was given incorrectly in the Dec. 1 issue of THE FOUNDRY on Page 80. Mr. Knight is sales engineer, National Engineering Co., Chicago.

Clyde C. Elmes, formerly superintendent, Baldwin Locomotive Works, Philadelphia, has been elected vice president and general manager, Dallett Co., Philadelphia.

# Gray Iron

## Possesses

# Valuable Engineering Properties

### Part XII

WHEN a piece of gray iron is heated it expands in a rather uniform manner. If certain temperatures are not exceeded, the metal resumes its original length and volume when temperature is brought back to normal. An expansion curve of a gray iron is shown in Fig. 80. The relative amount of expansion or of contraction is indicated as the coefficient of expansion or contraction as previously explained. This expansion is determined on an instrument known as a dilatometer, a simple form of which is shown in Fig. 79. The coefficients of expansion vary somewhat according to the type of iron and the size of the test bar as cast. This is readily apparent from inspection of Table X. It would appear that the stronger type irons have a greater expansion coefficient than do the weaker types, and the small bars (¾ inch as cast) have a fairly high coefficient. At the 1 inch size this drops markedly. However from this point on increase in bar diameter apparently results in 1 inch size this drops markedly. However in the first two cases, there is another decrease at the 3 inch diameter bar.

The experimental data given is too scanty to form any general conclusions as to the real reasons for the changes indicated by the variation in bar size. However, the difference between strong and weak irons probably suggests that the irons containing more graphite have more voids so that the expansions of the metal indicate that of the matrix only—for the expansion of the graphite, if compacted, is higher than that of the matrix.

The effect of increase in carbon in substantially pure iron-carbon alloys (low silicon) is shown in Table XI based on work by Driessen.

In recent years a number of attempts have been made to investigate the mechanisms of certain reactions in gray irons by dilatometric analysis. The effects of temperature changes on the structural condition of the metal may be investigated by various types of thermal analysis. For example the ordinary cooling rate curve indicates changes in state or in constitution because these changes are accompanied by changes in internal (heat) energy—a calorific effect. In a like manner, magnetic and electrical properties exhibit discontinuities as a result of certain changes in state or in constitution.

Expansion or dilatrometric studies also may be utilized in studies of this type. As a rule the expansion of an aggregate never deviates greatly from what may be predicted from the law of mixtures that is, the properties are additive. That generally makes interpretation of many dilatometric analyses fairly simple. However, in a mixture as complex as gray iron, apparent anomolies must be given careful consideration before

### Growth Occurs

*THE phenomena of expansion and contraction of metals under increasing or decreasing temperature changes readily may be observed with an instrument called the dilatometer. A simple form of that device is shown in this article. However, when the temperature exceeds 1200 degrees Fahr., gray iron does not return to its original volume. This permanent increase in volume usually is referred to as growth. Reasons for such growth are discussed in this article which is the twelfth of a series. The eleventh appeared in the Dec. 1 issue.*

**Table X**

## Coefficient of Expansion and Growth

| Material | Bar Size | Temperature Range Degrees Fahr. | Coefficient of Expansion Fahr. | Degrees Cent. |
|---|---|---|---|---|
| Soft cast iron | 1.2-inch turned to ¾-inch* | 74 to 1000 | 7.21 x $10^{-6}$ | 12.98 x $10^{-6}$ |
| | ½-inch | 74 to 1000 | 7.37 x $10^{-6}$ | 13.27 x $10^{-6}$ |
| | ¾-inch* | 71 to 1000 | 7.36 x $10^{-6}$ | 13.25 x $10^{-6}$ |
| | 1-inch turned to ¾-inch | 68 to 1000 | 6.94 x $10^{-6}$ | 12.49 x $10^{-6}$ |
| | 2-inch turned to ¾-inch* | 74 to 1000 | 7.44 x $10^{-6}$ | 13.39 x $10^{-6}$ |
| | 3-inch turned to ¾-inch* | 71 to 1000 | 7.37 x $10^{-6}$ | 13.27 x $10^{-6}$ |
| Cupola Semisteel | ½-inch | 76 to 1000 | 7.34 x $10^{-6}$ | 13.21 x $10^{-6}$ |
| | ¾-inch** | 84 to 1000 | 7.59 x $10^{-6}$ | 13.66 x $10^{-6}$ |
| | 1-inch turned to ¾-inch** | 75 to 1000 | 7.35 x $10^{-6}$ | 13.23 x $10^{-6}$ |
| | 2-inch turned to ¾-inch** | 84 to 1000 | 7.63 x $10^{-6}$ | 13.73 x $10^{-6}$ |
| | 3-inch turned to ¾-inch** | 72 to 1000 | 7.57 x $10^{-6}$ | 13.63 x $10^{-6}$ |
| Low carbon iron | 1.2-inch turned to ¾-inch*** | 70 to 750 | 7.47 x $10^{-6}$ | 13.45 x $10^{-6}$ |
| | 2-inch turned to ¾-inch*** | 70 to 1000 | 8.30 x $10^{-6}$ | 14.94 x $10^{-6}$ |

*Carbon, 3.50 per cent; silicon, 2.15 per cent } { phosphorus, 0.25 to 0.35 per cent.
**Carbon 3.50 per cent; silicon, 1.70 per cent } { manganese, 0.50 to 0.60 per cent.
***Carbon, 2.80 per cent; silicon, 1.75 per cent } { sulphur, 0.07 to 0.09 per cent.

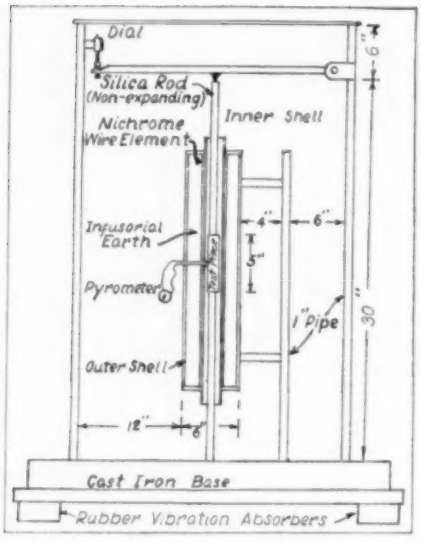



*Fig. 79—Sketch Showing Principle Parts of a Simple Dilatometer*

judgement is passed. Such a metal may not be absolutely solid. Microscopic voids or compressible components may give rise to unexpected results.

An interesting utilization of dilatrometric methods was made by Boegehold in his study of certain characteristics of pig irons. He found that the dialation characteristics of the pig iron influence those of the cast iron made therefrom. This is indicated in Fig. 81.

Growth of cast iron usually means the permanent increase in volume which often occurs when gray iron is repeatedly subjected to alternate cycles of heating and cooling. The maximum temperatures generally are 1200 degrees Fahr. or above, although in presence of certain corroding agents, such as superheated steam, growth may occur at considerably lower temperature. Growth of cast iron was observed many years ago, one of the first written comments being that of T. Beddoes, Royal Society, England, 1791.

### Heats Iron Repeatedly

It was somewhat over 25 years ago that the late A. E. Outerbridge *Transactions*, American Institute of Mining and Metallurgical Engineers, 1904, first presented some really good research on effects of repeated heating and cooling gray irons over certain temperature cycles. He showed gray irons undergo permanent and continued expansion under such treatment.

At the meeting Outerbridge exhibited—"bars of soft cast iron containing over 3½ per cent free carbon and less than 0.25 per cent of combined carbon which subsequently had been permanently enlarged about 40 per cent in cubical volume, and were subsequently increased to 46 per cent, after which no further permanent increase in bulk was obtained by subsequent heating." In his tests—"At first a temperature not exceeding 1200 degrees Fahr. was maintained and under these conditions it was necessary to heat and cool the bars about a hundred times to obtain an increase in cubical dimensions equal to that shown in the bars submitted herewith. By increasing the temperature to about 1450 degrees Fahr. an increase in length of about 1/16 inch per heat was obtained. The bar submitted for your inspection, which shows an increase over its untreated companion bar of 1 11/16 inches in length and ⅛ inch in cross section (over 40 per cent) has been heated and cooled 27 times." Outerbridge concluded his work as follows:

"All grades of cast iron do not increase in cubical dimensions equally. Soft iron, containing but little combined carbon increases more rapidly than harder iron, while white iron in which nearly all the carbon is in the combined form, does not expand sufficiently to overcome the original shrinkage, even after all of the combined carbon has changed to graphite, or rather, to that form of free carbon known as Ledebur's *temper* carbon by this annealing process, the astonishing change in volume is a molecular not a chemical one, this substantiating my original theory of the molecular mobility of cast iron."

### Growth Factors Enumerated

The work of Outerbridge shows careful observation and keen deduction. Ignoring the possibility of inaccuracy of temperature measurement, his findings may be summarized as follows: Repeated heating and cooling at elevated temperatures causes permanent growth; rapidity and amount of growth increases with increase in temperature; different irons have different susceptibility to growth; growth is not due to graphitization alone; growth is accompanied by loss in strength, and growth for a given iron finally reaches a limit after a sufficient number of cycles of heating and cooling.

In September 1909, Rugan and Carpenter presented a voluminous 101-page paper before the British Iron and Steel Institute. They were somewhat critical of some of Outerbridge's findings and a rather lively controversy followed. Rugan and Carpenter's conclusions showed that cast iron exposed to cycles of heating and cooling in an oxidizing atmosphere there is an increase in weight. They attributed this to—"the disintegration of the material due the oxidation of the ferrous silicide into ferrous oxide and silica by the furnace gases." Further Rugan and Carpenter claimed that in the case of close grained irons some of the growth is due to the expansion of dissolved gases. Vacuum heating was resorted to in some of these experiments.

### Alternate Cycles Are Necessary

As in Outerbridge's experiments, they too claimed that bars of gray iron started growth at about 1200 degrees Fahr. This reached its maximum after 3 hours at 1350 degrees Fahr., and alternate heating and cooling was essential to continued growth. Outerbridge had suggested the expansion of irons by growth in cases where castings were slightly under-dimensioned. Rugan and Carpenter, from another point of view, suggested that troublesome growth could be overcome by employment of white irons. Rugan and Carpenter also showed directly that propensity toward growth is proportional to silicon content, in the range 1.0 to 3.5 per cent silicon. Phosphorus tends to diminish growth. Sulphur in the usual ranges causes retardation, proportional to the percentage present. Manganese retards growth.

Most of the original interest in the subject of growth of cast iron arose

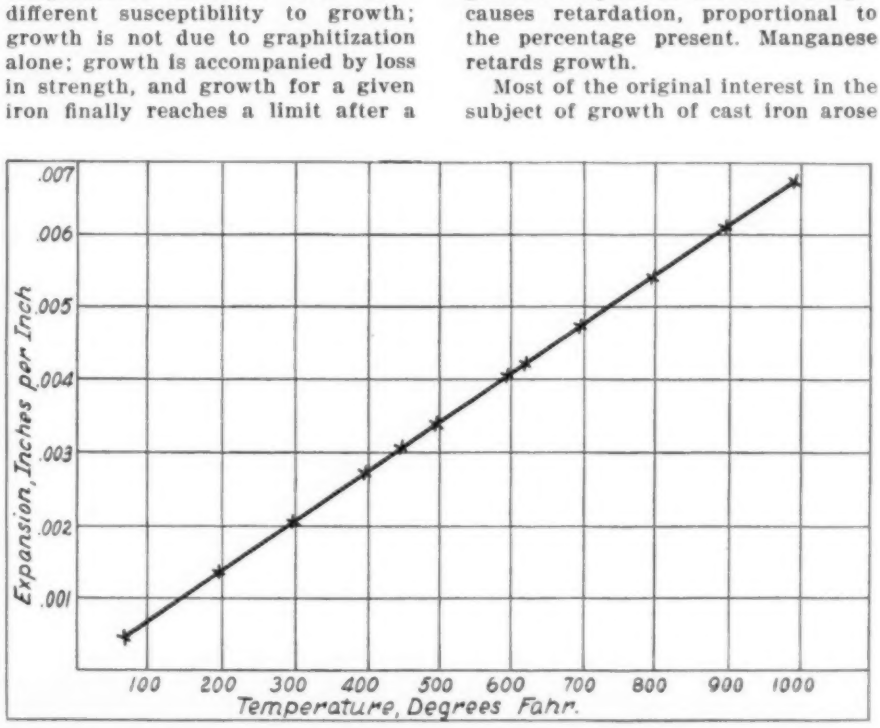



*Fig. 80—Expansion Curve of a Gray Iron from 70 to 1000 Degrees Fahr.*

from trouble with grate bar and stoker parts, the failure of ingot molds, and castings used in like application. In 1910 Prof. I. H. Hollis introduced a symposium presented before the American Society of Mechanical Engineers, as follows:

"The failure of a large number of cast iron fittings in use with superheated steam has rightly created a widespread suspicion of this material when exposed to high temperature. Yet on this subject there is little information of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast iron fittings. The latter have been used with success for many years at all degrees of temperature below actual redness, and in many stations now in operation with moderate degrees of superheating (say 100 degrees Fahr.) cast iron has never given the slightest trouble beyond the ordinary wear and tear. The doubt as to the reliability of cast iron has arisen with its use in long pipe lines to steam turbines where the temperature has ranged from 550 to 600 degrees Fahr."

### Experiences Were Contradictory

In the papers and discussion submitted at that time there were many contradictory experiences cited. American engineers were pretty well divided on the subject and the English engineers favored cast steel. The upshot of the whole matter is that today engineering societies indicate that 450 degrees Fahr. is the maximum temperature proper for cast iron used in steam service. Some manufacturers indicate that their products are safe up to 550 degrees Fahr. However, it is pertinent to point out that in many cases which were investigated, the real trouble lay in the supplying of improper grades of gray iron. At least one of the larger valve companies with an excellent record for quality products had no trouble with any installations made for moderate superheats, and manufactured before the general adoption of cast steel valves.

A large number of papers have been presented since these earlier investigations were published. A few of these will be cited.

Messerschmitt, *Geisseri Zietung*, 1913, offers the conclusion that growth is due to the oxidation of silicon which take place only when graphite is present. In 1914 Moissan showed that all graphites obtained from liquid metal at a high temperature have the property of swelling rapidly when heated to dull redness. He attributes this to sudden evolution of entrained gases.

### Oxidation Is Cause

In a paper presented before the Staffordshire Iron and Steel institute in 1916 Carpenter discussed the action of superheated steam on cast iron. His investigation led him to conclude that oxidation is the prime cause of growth and that the steam forces its way in between the incipient cracks caused by the expansion of the graphite and products of oxidation. On cooling, as pointed out by Stead, these cracks do not close entirely. This is an explanation of why gray iron *grows* when heated in a vacuum. These statements, as far as can be found, probably are the first involving the conception of incipient fractures as a phenomena encountered in growth formation.

In the 1917 edition of his monumental work, *Principles of Iron Founding*, Moldenke emphasizes the differences in specific gravity noted by Outerbridge; for example dropping from 7.13 to 5.49. Where white iron will not do Moldenke suggests selection of an extremely close grained iron, "just beyond a mottled fracture and on the way to grayness."

In a paper presented before the British Iron and Steel institute in 1918, J. E. Hurst suggests that surface decarburization of gray iron by heating in iron oxide would prove effective in preventing growth. He considered the primary cause of growth the presence of free graphite plates which allow the entry and penetration of the oxidizing gases into the interior of the iron.

More recent work of German investigators throws doubt on the continuity of the graphite plates. In their experiments they attempted to pass gases through very thin layers of iron and were not successful in so doing except in layers as thin as lengths of individual plates. However it is a matter of common observation that open or coarse grained irons usually are far more susceptible to growth than are the closer varities. An explanation alternative to that of Hurst will be offered later.

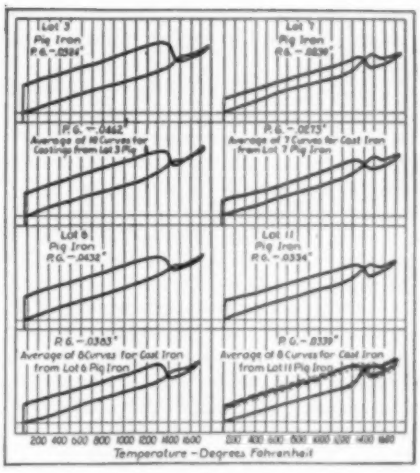



*Fig. 81 — Dilatation Temperature Curves for Pig Iron and Castings Made from the Pig Iron*

### Graphite Absorbs Gas

In 1920 Okochi and Sato, Tokyo Imperial university, also suggested surface decarburization to prevent growth. They indicate that from a temperature viewpoint there are two types of growths, one at the transformation range, the other above this range. The latter case is explained as permanent expansion due to the pressure of occluded gases. They claim that the flakes of graphite absorb a large amount of gas. The pressure of the gases and the plasticity of the metal itself increase with increase in temperature. That allows penetration of the gases. At any given temperature equilibrium is established. Raising the temperature causes further expansion. Cooling reduces the gas pressures and causes penetration of the gases through passages along the flakes of graphite from the surface of the metal. That part of their explanation is open to the same criticism as the theory of Hurst.

Okochi and Sato also considered the reaction in the transformation range due to the presence of occluded gases. The transformation from alpha to gamma iron is accompanied by contraction which the pressure of gases resist so that, according to the authors, the time for transformation is extended. They indicated that the constituents of gray iron play no important part in the problem of growth. Their experiments showed that when heated in hydrogen the metal shows the same growth as when heated in air. That, they felt,

**Table XI**

## Effect of Carbon Increase on Expansion

| Analysis | | | Mean Coefficient of Expansion, (20—t) degrees Cent. | | | | | |
|---|---|---|---|---|---|---|---|---|
| C | Mn | Si | 100 | 200 | 300 | 400 | 500 | 600 |
| 0.06 | 0.08 | tr. | 0.0000117 | 0.0000123 | 0.0000130 | 0.0000136 | 0.0000142 | 0.0000146 |
| 0.81 | 0.10 | 0.06 | 0.0000110 | 0.0000116 | 0.0000124 | 0.0000132 | 0.0000138 | 0.0000142 |
| 1.67 | 0.17 | 0.11 | 0.0000104 | 0.0000103 | 0.0000114 | 0.0000123 | 0.0000131 | 0.0000137 |
| 1.97 | 0.15 | 0.08 | 0.0000099 | 0.0000100 | 0.0000111 | 0.0000122 | 0.0000131 | |
| 2.24 | 0.15 | 0.08 | 0.0000096 | 0.0000096 | 0.0000110 | 0.0000121 | 0.0000132 | |
| 3.66 | 0.14 | 0.09 | 0.0000086 | 0.0000088 | 0.0000099 | 0.0000113 | 0.0000125 | 0.0000132 |
| 3.80 | 0.16 | 0.05 | 0.0000087 | 0.0000085 | 0.0000101 | 0.0000115 | 0.0000126 | |

Phosphorus and sulphur were low in all cases. The samples were tested in the annealed condition after a heat treatment of 30 minutes at 1000 degrees Cent.

indicated the relative unimportance of oxygen in bringing about the phenomena.

In 1922 Campion and Donaldson presented a paper on growth before the Institute of British Foundrymen. They indicate semisteels are less subject to growth than are softer gray irons. In the same year Kikuta in a paper reported before the Tohoku Imperial university showed results obtained in subjecting a hollow cast iron cylinder to pressure at elevated temperatures. His results showed that air leakage increased up to 60 heatings and decreased thereafter. The range of temperature investigated was 1400 to 1650 degrees Fahr. He blamed the growth on presence of occluded gases, as did his countrymen Okochi and Sato.

Durand's experiments are given in *Comptes Rendus*, 1922. He showed that growth increased directly with silicon content and also is related to the rate of heating. The temperature range studied was 1100 to 1650 degrees Fahr. In 1924 Andrew and Hyman presented a paper before the British Iron and Steel institute indicating, that nickel and aluminum which are promoters of graphitization, accelerate growth, while chromium, which stabilizes the carbides, retards it. They did not increase the nickel content until an austenitic structure was obtained.

J. H. Andrew and Robert Higgins studied the dilatation of cast irons during repeated heating and cooling. The original paper was presented before the British Iron and Steel institute in 1925. The general conclusions are that graphitization does not serve as a suitable explanation of all the reactions involved in the growth of cast iron. Oxidation of the iron plays a probably greater part in the actual increase in volume. "At the temperatures concerned oxygen has a greater affinity for iron than for carbon, and it was found that it was not until a considerable amount of $Fe_2O_3$ was formed that decarburization proceeded with any avidity.

### Growth Factors Indicated

"In immediate contact with the unchanged iron there would be the lower oxide (FeO) which at the higher temperatures would diffuse to a limited extent into the metal and oxidize the small particles of temper carbon previously formed, giving rise to a further change in volume and to the formation of carbonaceous gas. There is no relation between chemical composition and growth shown by these curves (i.e. in the grades of iron studied). Growth is however, dependent on so many factors that in a heterogeneous material, as cast iron, such relation is not to be expected. Growth must, for instance, be dependent on the amount of graphite, on the size and distribution of graphite flakes, upon the form of combination of the manganese, and other variable factors. * * * * The curves—do point to the delaying action of phosphorus. * * * An important conclusion * * * is that it is imperative that the silicon content be low. * * *"

Kennedy and Oswald, *Transactions* American Foundrymen's association, 1926, concluded that higher phosphorus irons (1.56 per cent phosphorus) had the least growth. Also, an iron deoxidized with titanium grows much more slowly than iron of similar composition minus titanium. They offer the explanation that the steadite envelops prevent the penetration of gases and consequent growth. In the same publication a paper by Smalley devoted to discussion of heat and scale resisting cast irons concludes that any practice conductive to initial oxidation shortens the life of gray iron exposed to heat oxidizing conditions, and that either deoxidizers or duplexing will be beneficial Calcium silicide is mentioned as a deoxidizer. Low silicon (0.80 per cent) is desirable. Smalley also claims that high carbon also is desirable. This seems a rather doubtful conclusion, in view of our later knowledge of the better growth resistant properties of some of the low carbon high test irons.

### Discusses Superheating Effects

While E. Piwowarsky, *Transactions*, American Foundrymen's association, 1926, discussed principally the effects of superheating molten metal in its relation to production of high test iron, a substantial portion of his article is devoted to the causes of growth. Piwowarsky showed that superheating, promoting extremely fine graphite formation, added decided resistance to growth. However, much of this advantage is lost by too high silicon content, and is not counteracted fully by suitably low total carbon content. He also demonstrated that vacuum heating will produce growth, although not as great as heating under oxidizing conditions.

Piwowarsky indicates that a single structure matrix is desirable. Growth takes place in an atmosphere of nitrogen, and a slight increase in weight indicates probable nitriding of the surface. His tests were conducted on cycles of 750 to 1830 degrees Fahr. However, he concludes that growth tests with maximum point in the cycle about 1380 degrees Fahr. are sufficient to demonstrate the growth characteristics of the material. Tests conducted heating to 570 degrees Fahr. in rapeseed oil and cooling to —300 degrees Fahr. (liquid air) showed no growth, but rather some reduction in volume.

He ran growth tests in steam and steam-air mixtures at 570, 660, and 870 degrees Fahr., for 75 hours. There was considerable surface oxidation in all tests. With steam at 660 degrees Fahr. there was oxidation in the centers of those bars richer in silicon and with poor graphite development. With steam at 850 degrees Fahr. there was practical freedom from oxide formation in the better grades of metal, yet the poorer grades were affected considerably. Admission of air with the steam aggravated the bad results. Piwowarsky says that even graphite flakes removed from direct connection with flakes near the surface also show the oxidized phenomena.

Piwowarsky indicated that it may be possible to produce irons of dense grain and suitable composition which will be capable of resisting steam even at high temperatures. Presumably he means up to 840 degrees Fahr. as maximum temperatures in modern central station operation already have reached 750 degrees Fahr. However, the objections to gray iron castings for superheated steam service are not based wholly upon its occasional propensity toward growth.

### Decarburization Not Cause

C. E. Pearsons *Carnegie Memoirs*, 1926, indicated that initial stages of growth are caused by graphitization. However, in the cycles from room temperature to 1650 degrees Fahr. the silicon finally was completely oxidized to silica and some of the iron also was oxidized. Decarburization itself is not responsible for the growth. Growth starts mostly at the outside layers and proceeds gradually toward the center. However, Pearsons noted that the pearlite in the center was the first to be broken down to ferrite and graphite.

Only slight growth was found when heating in vacuum and Pearson felt this in part due to expansion of occluded gases. Heating in an atmosphere of carbon dioxide produced greater growth than heating in a muffle where presumably carbon monoxide, carbon dioxide and nitrogen were present. Tests on different sized bars indicate that a critical size of graphite particle is most favorable to growth.

R. Higgins, *Carnegie Memoirs*, 1926, examined two series of irons. One was low in phosphorus and with manganese from 4.04 to 5.25 per cent, and the other low in manganese with phosphorus 1.3 to 4.2 per cent. He found that increase in manganese protects the iron against changes in coefficient of expansion and hence retards growth. Increase in phosphorus retards growth by protection of the iron from oxidation. Higgins indicated that oxidation and graphitization are the major causes of growth.

Sipp and Roll, *Geisserei Zeitung*, 1927, indicate the relationship of growth to silicon content, and no close correlation with the percentage of total carbon was indicated. They claim nickel up to 1.0 per cent has no marked effect on growth. Their

(*Concluded on Page* 78)

# Chromium Cast Steels Resist Heat and Corrosion

By H. D. Phillips

HEAT and corrosion resistant alloys of chromium and iron, or chromium, nickel and iron, generally fall into three separate groups or classes, as follow: Ferrites, with but little carbon, being malleable and employed with but little heat treatment; martensites, nonmalleable, being used after hardening and austenites, solid solution alloys of iron, nickel, chromium, carbon, and at times silicon, which are malleable even after quenching.

These alloys each have a high resistance to nitric and phosphoric acids, and generally fall within separate price scales. They are applied extensively in the chemical and process industries in the form of castings and their use is increasing rapidly.

### Carbon Must Be Regulated

Steel may be strengthened by the addition of one or more alloying elements but in doing so we must regulate closely the accompanying carbon content. Each one of the alloying elements has its own idiosyncrasies. It may be cheap or costly, domestic or imported, easy or hard to handle, and it confers quite definite properties upon the steel. Some of the alloying elements go together, giving a much more acceptable result than either alone.

In the heat and corrosion resistant field for steel castings, there are generally but two elements and their effect upon the carbon present, to be considered. These elements are chromium and nickel. As chromium is added to steel up to the stainless analysis (12 to 14 per cent) and beyond, it does several significant things: First, the amount of carbon held in the eutectoid composition is reduced materially. Second, the critical temperature is raised. Third, the rate of carbon diffusion through the metal is diminished rapidly, slowing down also the rate at which casting strains can be removed by heat treatment. Fourth, the steel with the lower ranges of chromium has the property of air hardening.

While in a plain carbon steel the eutectoid composition is about 0.90 per cent carbon, in a steel containing 12 per cent chromium it will be about 0.30 per cent carbon. As an example, a steel with 0.50 per cent carbon and 12 per cent chromium will contain relatively as much free cementite as a plain carbon steel of 1.40 per cent carbon. Under the microscope, that chromium steel displays a characteristic pearlite grain structure enclosed in an envelop of free cementite. The chromium is present in both the ferrite and cementite, being in solution with the ferrite and forming at the same time a complex iron-chromium carbide.

Chromium, in raising the critical temperature, necessitates a higher temperature to relieve casting or working strains. For the heat treatment to be effective, it must be held at the higher temperature for a longer time than would be the case with a plain carbon steel. Chromium has the effect of diminshing the rate at which the carbon diffuses through the metal. In the 12 to 14 per cent and up to 18 and 20 per cent chromium range, the steel has the property of air hardening when the carbon is in excess of 0.10 per cent. This can be understood easily by remembering the slow rate of carbon diffusion and likewise precipitation in the chromium steels.

Whereas chromium raises the recalescence points in carbon steels, nickel has the opposite effect, depressing the critical points, and according to the degree of such depression, three groups of nickel steels may be considered: Pearlitic steels, which have normal transformation and heat treatment, or critical ranges, and are in a general sense similar to ordinary carbon steels; martensitic steels, self-hardening but too brittle to be of any great commercial importance, and austenitic steels, which are not susceptible to hardening by thermal treatment. The nickel and carbon content of the steel determines its places in any one of the above groups. Fig. 4 according to Guillet gives a classification of different compositions of nickel steels.

### Nickel Affects Properties

Nickel dissolves in the ferrite of steel and increases the hardness and strength without the usual corresponding loss of ductility. It exerts an influence on the grain size of ferrite and pearlite and tends to produce a finer grain structure and finer pearlite. In the same sense nickel diminishes the rate of grain growth within the heat treatment temperature ranges, and thus minimizes the danger of overheating during heat treatment.

As nickel is added to a low carbon

*Fig. 1—Valve Parts for High Temperature Crude Oil Distillation Made from an 18 Per Cent Chromium—8 Per Cent Nickel Alloy. Fig. 2—Nozzles of High Chromium-nickel Alloy for Resisting Sulphuric Acid Solutions. Fig. 3—Buckets of a 25 to 30 Per Cent Chromium Alloy for Handling Hot Copper Sulphate*

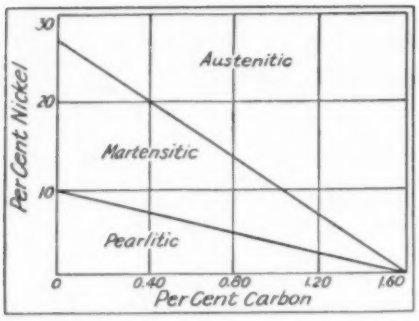



*Fig. 4—Structural Classification of Nickel Steels According to Guillet*

steel, the critical temperature is dropped lower and lower until 25 per cent nickel is reached, when the allotropic transformations occur below atmospheric temperatures. The steel ordinarily does not cool to the point where the solid solution decomposes, and the alloy has an austenitic composition, or the carbon is still in solid solution in the ferrite and the critical transformations do not take place.

When chromium is added to a nickel steel, the same occurrences as mentioned previously are observed, except that in the presence of chromium much less nickel is required to suspend the critical transformations than when chromium is not present. Most of the nickel present is in solution with the iron, or with the chromium and iron, in a nickel-chromium steel, but a small part of it is probably combined with the iron-chromium carbide which in turn is dissolved inextricably in the nickel-chromium-iron matrix.

### Secure Desired Properties

When nickel and chromium are present together, the good properties of each are enhanced by the other. While the nickel steels above 25 per cent nickel are austenitic, chromium up to 30 per cent will not produce an austenitic alloy. By an addition of nickel to a high chromium steel, the metal is changed to the austenitic structure and likewise, as has been mentioned, an addition of chromium to a nickel alloy not quite high enough in nickel to be austenitic, renders a change in the metal structure to the austenitic type. The desired results are accomplished by properly proportioning the alloys present.

Austenitic alloys are fine grained, strong, tough, ductile, and nonmagnetic, and if desired can be made more ductile by heating to a high temperature of 2000 to 2100 degrees Fahr. and quenching in water. In the cast structure of these metals usually there is some martensite present, which has separated out due to the long slow cool from casting temperatures, and the heat treatment and quench restores this to its austenitic condition.

The amount of carbon present in a high-chromium or chromium-nickel steel is important. However, these alloys are perhaps more sensitive to small changes in the carbon content than is the case with a plain-carbon steel. The resistance to corrosion and machinability both are increased by keeping the carbon down. The reason for the increased machinability can be realized easily when the high affinity of chromium for carbon is considered.

Of the chromium available in the steel, some of it, as has been explained previously, forms a complex carbide with the iron, the remainder goes into solution with the iron. The part going into solid solution with the iron is of the greatest importance in resistance to corrosion. It has been shown that to bring about true rustlessness, that is, resistance to attack under ordinary atmospheric conditions, a minimum chromium content of approximately 11.50 per cent is required in the ferrite constituent of the steel. With about 0.10 per cent carbon and a chromium content of 12 to 14 per cent, a properly made, clean rustless iron is substantially rust proof under ordinary atmospheric corrosive conditions.

### Complex Carbide Forms

If the carbon content is increased to 0.25 to 0.30 per cent for the purpose of obtaining greater hardness, or for reasons of economy, sufficient carbide of chromium or complex carbide of iron and chromium could be precipitated to destroy the rustless quality so that nothing short of a quench from high temperature prevents precipitation of the carbides and consequent robbing of the solid solution of sufficient chromium. The effect of 25 to 30 points of carbon on stainless steels that have not undergone proper heat treatment is decidedly marked. That is to say, they are not nearly so rustless as are the rustless irons or heat treated stainless steels. For a given low carbon content of approximately 0.10 per cent, the corrosion resistance of these alloys increases with the chromium content, but the hardening capacity within certain limits decreases with an increase of chromium.

High carbon chromium steels with carbons up to 0.80 per cent give good service in withstanding oxidation at high temperatures and seem to be practically as good as the lower carbon chromium steels in that particular field of service. The foundryman prefers the higher carbon steels, as they possess greater fluidity and thus ease the casting problem to some extent.

### Physical Properties Indicated

A general idea of the physical properties of a few of the chrome and chrome nickel steels may be obtained by referring to Tables I and II. Ability to withstand a specific type of service is not indicated necessarily by physical test results which usually indicate nothing but the maximum strength with the minimum ductility, and its extreme, the maximum ductility with the minimum strength. The intermediate values largely are left to be conjured, but it is believed that a more thorough understanding of the alloy is made possible by giving the results of physical tests.

The electric furnace now is claimed to be the best and most economical means of producing high chrome and chrome-nickel alloy steels, conforming to close chemical and physical requirements on a production basis. Either acid and basic practice may be used in making these steels but the acid electric furnace seems to be used more extensively than the basic furnace in melting these steels for castings. By careful control and operation, high quality steel can be produced successfully by either practice with low alloy losses.

In the basic electric melting practice for these steels, if any of the return scrap or scrap containing large percentage of chromium is used, it is best to make up the remainder of the charge with low, phosphorous scrap so

**Table I**

## Analysis of Some Alloy Steels

| Alloy No. | Carbon Per Cent | Chromium Per Cent | Nickel Per Cent | Manganese Per Cent | Silicon Per Cent | Copper Per Cent | Molybdenum Per Cent |
|---|---|---|---|---|---|---|---|
| 1 | Under 0.15 | 12.00 to 14.00 | Under 0.50 | 0.40 to 0.50 | 0.40 to 0.60 | Under 0.30 | None |
| 2 | Under 0.25 | 17.00 to 19.00 | Under 0.50 | 0.40 to 0.50 | 0.40 to 0.60 | Under 0.30 | None |
| 3 | Under 0.30 | 21.00 to 23.00 | Under 0.50 | 0.40 to 0.50 | 0.40 to 0.60 | 0.75 to 1.25 | None |
| 4 | Under 0.35 | 25.00 to 30.00 | Under 0.50 | 0.40 to 0.50 | 0.40 to 0.60 | Under 0.30 | None |
| 5 | Under 0.20 | 17.00 to 19.00 | 7.00 to 9.00 | 0.40 to 0.50 | 0.90 to 1.25 | Under 0.30 | Trace |
| 6 | Under 0.30 | 10.00 to 12.00 | 22.00 to 24.00 | 0.40 to 0.50 | 0.90 to 1.25 | Under 0.30 | 1.00 to 1.50 |

that slagging off will not be necessary. A large amount of the chormium is oxidized during melting and thus would be lost if the first or oxidizing slag were removed. With the one slag process the basic furnace can be speeded up greatly and more adequately meet the demands of the foundry. The increased cost of the low phosphorous scrap is offset many times by the savings in alloy charged, power and time.

Light turnings and other excessively light scrap generally are avoided and as a rule at least one-third of the charge is fairly heavy scrap such as heads and gates. Ordinary basic melting practice is followed with the exception that the first slag is made the deoxidizing and desulphurizing one. The slag is treated with coke dust until properly deoxidized, the alloy added, and the metal tapped. The heat should not be tapped if the slag shows even a faint apple green color, as this is a sure indication that chromium is still in the slag. Further additions of coke and lime should be made until the slag shows its usual gray, powdering condition. All additions of ferrochromium generally are made when the bath is melted completely and the carbide slag has formed.

### Furnace Should Be Sealed

In the acid process no great reduction can be accomplished, and unless great care and control are exercised in melting, the chromium losses may be high. Light scrap and turnings should be avoided, as in basic practice, and it is as a rule good practice to seal the furnace during melting down. All delays during the melting period should be avoided and this in turn reflects upon the furnace. The melting-down period is the only opportunity for *making time* without effecting the final product.

Losses of chromium in making high chromium steels may vary in different foundries. In a properly operated basic furnace, the chromium losses should not exceed 4 per cent, while in a properly operated acid furnace they should not exceed 6 per cent. The values given represent the percentage of the total chromium added and not the percentage of chromium in the steel, as in the latter case a loss of 5 per cent chromium in a 20 per cent chromium steel would represent an alloy loss of 25 per cent. The loss of nickel in either practice is practically nil, and in only rare cases is less than a 95 per cent recovery of the element obtained in the steel.

### Temperatures Appear Low

It is extremely hard to judge the temperature of these metals and one experienced in judging temperatures of ordinary steels is quite sure to estimate or read low in attempting to ascertain the temperature of a high chromium or chromium-nickel steel. It is desirable, though seldom practical, both from the viewpoint of the mold and the quality of the metal, to cast on the low side or low temperature, but due to the high casting temperatures generally found and usually necesary, a highly refractory sand is needed.

A fine, uniform grain size sand, of the nature of the ones given in Table III, is ideal for green sand molding of these metals, when bonded with bentonite and a cereal binder. Either green or dry sand practice may be used, the same general considerations governing the selection of either one practically in the same manner as with an ordinary steel. It is also the best practice to use an artificially bonded silica sand for the dry sand work. A few general conditions of the sand to be controlled and maintained consistently are as follows:

The moisture should be controlled so as to allow proper molding. In green sand work avoid spraying of the sand after it is in the flasks which would naturally result in localized wet and impermeable spots. The permeability of the heap or backing sand should always be greater than that of the facing sand. The compressive strength in pounds per square inch should be great enough to allow quick and proper molding, without which it is possible that the sand may weaken and collapse. The grain size of the sand should be adjusted to give the desired surface on the casting. The silt, fines and active bond should be held under 10 per cent.

**Table III**

## Screen Analysis

(Green Sand)

| | Facing Sand | | Heap Sand | |
|---|---|---|---|---|
| MESH | Retained | Cumulative | Retained | Cumulative |
| 6 | .... | .... | .... | .... |
| 10 | .... | .... | .... | .... |
| 20 | .... | .... | .... | .... |
| 28 | 0.3 | 0.3 | .... | .... |
| 35 | 0.7 | 1.0 | 12.1 | 12.1 |
| 48 | 7.5 | 8.5 | 32.6 | 44.7 |
| 65 | 23.5 | 32.0 | 29.3 | 74.0 |
| 80 | 41.6 | 73.6 | 20.5 | 94.5 |
| 100 | 16.2 | 89.8 | 2.7 | 97.2 |
| 150 | 4.1 | 93.9 | 1.3 | 98.5 |
| 200 | 3.9 | 97.8 | 0.6 | 99.1 |
| 270 | 1.8 | 99.6 | 0.3 | 99.4 |
| Pan | 0.4 | 100.0 | 0.6 | 100.0 |

### Oxide Forms on Surface

The readiness with which an oxide or scum forms on the surface of a chrome or chrome nickel alloy is a source of much trouble to the foundryman. This oxide forming on the surface of the metal evidences itself in the ever present trouble with cold shuts. These cold shuts are really only skin deep and though unsightly

**Table II**

## Typical Physical Properties of Some Alloy Steels

| Alloy No. | Maximum Endurance Temperature Degrees Fahr. | Tensile Strength Pounds Per Square Inch | Yield Point Pounds Per Square Inch | Elong. in 2 in. Per Cent | Rad. of Area Per Cent | Brinell Hardness | Shrinkage Per Ft. Inches | Weight-Lbs. Per Cu. In. | Melting Point Degrees Fahr. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1200 | 65,000 to 75,000 | 45,000 to 55,000 | 15.0 to 18.0 | 20.0 to 30.0 | 166 | 1/4 | 0.28 | 2725 |
| 2 | 1600 | 70,000 to 80,000 | 45,000 to 55,000 | 12.0 to 15.0 | 16.0 to 18.0 | 207 | 1/4 | 0.28 | 2730 |
| 3 | 1800 | 55,000 to 65,000 | 40,000 to 45,000 | 4.0 to 8.0 | 8.0 to 10.0 | 183 | 1/4 | 0.28 | 2760 |
| 4 | 2000 | 50,000 to 60,000 | 35,000 to 40,000 | 2.0 to 5.0 | 2.0 to 5.0 | 183 | 1/4 | 0.28 | 2800 |
| 5 | 1800 | 80,000 to 90,000 | 40,000 to 50,000 | 45.0 to 55.0 | 40.0 to 50.0 | 166 | 1/4 | 0.285 | 2675 |
| 6 | 1800 | 75,000 to 85,000 | 45,000 to 55,000 | 22.0 to 28.0 | 25.0 to 30.0 | 159 | 1/4 | 0.29 | 2700 |

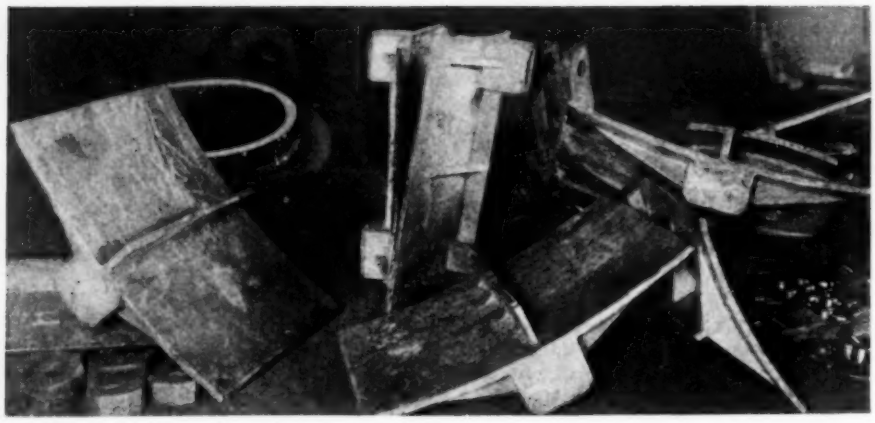


*Fig. 5—Liners for a Chemical Mill Made from a 25 to 30 Per Cent Chromium Alloy Made in the Electric Furnace*

are no serious detriment to the casting. The chromium bearing metal forms a protective coating on the surface of the metal, protecting that underneath. That scum or covering is quick in forming so that when two streams of metal meet in the mold a cold shut or wrinkle is formed.

The wrinkle is not serious because the heat and pressure of the bodies of metal causes a perfect union and the oxide is forced to the surface where the chilling action is most pronounced, merely causing a surface defect. Practically all of the lower carbon chromium and chromium-nickel steels are sluggish and usually require larger gates and higher pouring speed than the higher carbon alloys. The gates and risers should be arranged so that the metal can fill the mold with the minimum of delay and with as total an absence as possible of conflicting or over-lapping streams of metal.

### Feed Metal to Mold

Many problems must be met in the feeding of these metals in the mold. The main source of trouble in feeding an alloy casting lies in the low heat conductivity as compared to an ordinary steel. Low carbon alloy steels conduct heat approximately one-half as fast as mild steel. When the metal is poured against the surface of a sand mold, a skeleton the shape of mold is immediately frozen, but the metal inside the frozen skeleton can give up its heat only by conduction and convection through the solid envelop which in turn must pass the heat through the sand which is continually becoming hotter. As this skeleton becomes thicker, the time per unit of metal thickness becomes longer, and sections of substantial mass thus require a relatively long time to freeze. Therefore, the metal in the feeder-head must remain fluid for a correspondingly longer time to feed the casting properly. This may be accomplished either by shortening and thickening the neck, by increasing the size of the head or by changing location of gate and feeder heads.

Usual steel foundry pouring practice is employed in handling any of these metals. In both basic and acid practice, trouble is sometimes encountered with the slags in the ladle, but as has been mentioned before, with careful intelligent furnace operation, there will be little loss of chromium into the slag. The loss of chromium forms the troublesome constituent of the slag, chromic acid. Slag low in chromium can be handled as in ordinary steel heats.

High losses of chromium affect the cost of the metal, not only from the point of increased alloy additions necessary to obtain the requisite percentage, but also cause much trouble in the furnace and ladle by building up the bottom of the furnace and by causing frequent relining of the ladles.

Once the slag is in proper condition the metal either may be poured direct from a lip-pour ladle or poured into 50 or 100-pound ladles for pouring small castings. If a tea-pot or bottom-pour ladle is used, the precautions to be taken with the slag will not be necessary. The next consideration is the pouring or casting temperature of the metal.

Whenever practical, it is desirable to pour the metal into the mold at the lowest temperature consistent with the proper filling of the mold cavity. The casting temperature affects the final quality of the metal in many ways, and especially in the higher chromium series of steels the evil effects of high casting temperatures are pronounced.

Even with low casting temperatures, large grains are found in heavy metal sections, caused by the slow cooling from the initial casting temperature. At present there is no way known by which those large grains can be prevented, and heat treatment exerts but little influence upon them. These large grains are particularly objectionable in castings to be used for pressure work, as it may be seen that any seepage follows the grain boundaries. The formation of large grains is not to be dealt with in the lower chromium content steels or in the nickel-chromium steels, but even so, the casting temperatures should be controlled carefully.

### Follows General Practice

Cleaning of alloy steel castings follows to a large extent the usual steel foundry practice. The castings, as a rule, first sandblasted and the gates and risers are removed by electric arc cutting. The castings usually are heated before cutting off the excess metal so as to avoid excesive strains set up in the casting adjacent to the cut. It is often deemed advisable to leave from ½ to 1½ inches of neck or gate on the casting to be removed in the grinding operation. Unless care is exercised the great heat of the arc may overheat the metal locally and due to the poor heat conductivity cracks may start or the casting be so strained that it will crack upon being put into service.

Small castings of the nickel-chromium and lower chromium series of alloys may be sandblasted successfully in a sandblast barrel but there are dangers involved in attempting to clean any of the higher chromium steels in any such contrivance. These metals are as a rule fairly tender before heat treatment and must be handled with care throughout the cleaning operation. In the grinding of the castings a high speed grinder with specially prepared wheels result in great savings in both labor and money.

Next to correct composition, the most important factor in securing

*Fig. 6—Valve Parts Cast from an 18 Per Cent Chromium—8 Per Cent Nickel Alloy for Corrosion and High Temperature Resistance*

best results from alloy steels is proper heat treatment. As a rule all castings of these metals should be cleaned completely, and, whenever necessary, welded before heat treating.

In the 12 and 14 per cent chromium steel, if maximum softness is not desired, it can be annealed or rather tempered below the critical temperature. In that case it is heated to from 1250 to 1300 degrees Fahr. and cooled in air, while if maximum softness is desired it should be heated to from 1500 to 1550 degrees Fahr. and cooled slowly in the furnace, the temperature drop not exceeding 50 degrees Fahr. per hour to a point below the critical temperature. The 17 to 19 per cent chromium steel also may be softened by heating to 1300 degrees Fahr. and cooled in air. Maximum softness may be obtained by heating to from 1450 to 1500 degrees Fahr. and cooling in air or water. The water quench gives slightly greater ductility.

### Grain Size Diminished

The higher chromium steels of the 21 to 23 and 25 to 30 per cent analysis should be heated to 1600 degrees Fahr. and thoroughly soaked at this temperature for at least 12 hours and cooled quickly in air or water. The water quench is to be preferred as it diminishes the grain size. The length of time at which these steels are held at heat to relieve casting strains and to effect complete annealing will be considerably longer than with an ordinary steel casting. The reason for this has been given previously.

In many cases the austenitic alloy castings are not heat treated, though where no great danger to the casting is involved they should be heat treated. A greater ductility may be obtained by heating them slowly to 1200 degrees Fahr. and then rapidly to 2100 degrees Fahr., thoroughly soaking them at this temperature, and then quenching in water. This treatment changes all the martensite formed in the slow cool from casting temperatures into a desired austenitic structure.

The lower chromium series of steels may be hardened by quenching in air, oil, or water from a temperature above the critical range and then tempered to the desired hardness, much the same as a carbon or low alloy steel. However, as the chromium increases this property is lost, unless the carbon is increased to a proportionally higher degree. Resistance to abrasion may be secured by a high-carbon, chromium alloy consisting of an iron-chromium-carbide dissolved in an iron-chromium matrix. Such an alloy is resistant to extremely abrasive conditions but, as can be imagined, is extremely difficult to machine. The chromium steels, much like the carbon steels, have a distinctly graduated range of properties caused by variations in the carbon or chromium content. They have, however, a greater diversification of uses to which they can successfully be applied.

As is characteristic of all austenitic alloys, the nickel-chromium steels work-harden readily, and it is really the only manner in which they can be hardened.

Corrosion is linked inextricably with galvanic action and heterogeneity promotes galvanic action. This electrolytic action, so often the cause of failure of materials exposed to corrosive conditions, may develop from dirt particles introduced in the metal by careless molding or melting practice. Great care should be exercised in preventing dirt inclusions, such as silica and alumina in the metal and eliminating danger of heterogeneity from this source. The absence of, or improper heat treatment, is also the cause of galvanic action.

### Martensitic Structure Resistant

A hardened chromium steel with a martensitic sctructure is much more resistant to corrosion than one with a thoroughly annealed pearlitic structure. The chromium and the carbon are all in solution in the ferrite while in the martensitic state, and the alloy is therefore more homogeneous. This condition of homogeneity is also important with the austenitic steels and the quench from high temperatures aids greatly in improving its corrosion resistance. It is, in all cases, of vital importance that the steel be heat-treated properly.

The casting skin, on a casting to be submitted to exposure at high temperatures, is far more resistant than a machined surface, due to the small cracks or tears formed in machining. Resistance to corrosion and oxidation at high temperatures in a chromium steel is believed to be conferred by a dense complex coating of an oxide, forming on the surface of the metal, protecting the metal underneath.

# Research Group Reviews Literature

TWO main divisions of work to be covered by the Alloys of Iron Research which was organized in 1929 by the Engineering foundation, New York, in co-operation with the American Institute of Mining and Metallurgical Engineers and other technical societies, are a comprehensive and critical review of the world literature on iron and its alloys, and the promotion of fundamental research in that field. To assemble, critically review, and correlate the information scattered throughout the numerous books and periodicals in many languages, a committee of ten leading metallurgists was appointed. These are:

Chairman and director, G. B. Waterhouse, Massachusetts Institute of Technology, Cambridge, Mass.; H. W. Gillett, Battelle Memorial institute, Columbus, O.; C. K. Burgess, bureau of standards, Washington; Scott Turner, bureau of mines, Washington; R. E. Kennedy, American Foundrymen's association; Bradley Stoughton, Lehigh university, Bethlehem, Pa.; J. H. Critchett, Union Carbide & Carbon research laboratories, Long Island City, N. Y.; Jerome Strauss, Vanadium Corp. of America, Bridgeville, Pa.; T. H. Wickenden, International Nickel Co., New York, and J. A. Mathews, Crucible Steel Co. of America, New York.

Under the direction of Frank T. Sisco the editorial staff will review approximately 2000 technical and scientific journals from various parts of the world. For review purposes the chemical elements involved in iron and steel metallurgy have been divided into eight groups which include: Special; elements present in all iron alloys; common alloying elements; alloying elements occasionally used; miscellaneous heavy elements; alkaline earth elements; gases, and nonmetallic inclusions. Subjects covered will be methods of manufacture; constitution; properties; thermal treatment, and uses.

Results of the critical review will be published in book form as monographs for the teacher and research worker, and as manuals for the practical man, the engineer, the steelmaker and the user. Attention will be directed to probable errors and gaps in existing information. As review of the literature progresses, a valuable body of reference material will be built up. From that file bibliographies covering any or nearly 800 classifications in ferrous metallurgy may be compiled readily. Publication of the first monograph will be made in 1931. Subsequent volumes will follow as rapidly as practicable until all of the alloy systems have been covered.

Special assignments to co-operating groups have been made as follows: *Iron-silicon* to Bradley Stoughton, Lehigh university; *Iron-molybdenum*, *iron-tungsten* and *iron-carbon* to H. W. Gillett, Battelle Memorial institute; *Iron-manganese* to F. M. Walters Jr., Carnegie Institute of Technology, and *Pure Iron* to Louis Jordan, bureau of standards. Progress is being made on those assignments.

*Small Quantity of*

# Aluminum Improves Malleable Cast Iron Properties

By John H. Hruska

REGARDLESS of the fact that aluminum is being used to a considerable extent in the manufacture of various grades of structural and other commercial steels, its possible applicability for the modern malleable foundry hardly has been investigated. So far, the influence of aluminum upon the properties of black heart malleable has been summarized simply as *making the iron sluggish in pouring.* Upon investigation the statement is true if aluminum is added in large quantities as will be shown later. Small and definite percentages of aluminum seem to be beneficial to the physical properties of white iron of standard composition which is to be malleabilized.

### Foundry Knowledge Secured

As in all phases of metallurgical and industrial activities, there was a time not so far back when fairly good malleable iron was made within certain limitations established almost exclusively by the well-known rule of thumb methods. The inheritance of experienced foundrymen or the apprenticeship served in acquiring the secrets of the art were responsible for some of the greatest achievements in foundry routine of today.

Results of experiments carried out by some of the early leading minds of the industry also were definite steps in the possible developments of new methods of manufacture, new appliances and new compositions. In summing up it seems that the possibilities of improving the mechanical properties of black heart malleable by aluminum additions were investigated rather incompletely. With this fact in mind, a series of carefully planned and thoughtfully executed experiments were carried out—not with laboratory precision, but on a larger scale under manufacturing conditions.

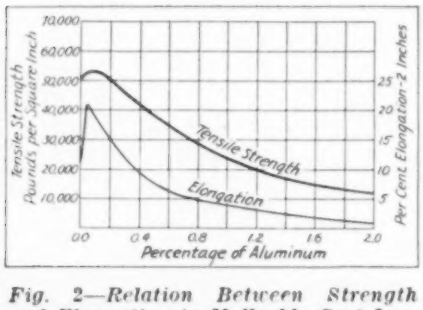



*Fig. 2—Relation Between Strength and Elongation in Malleable Cast Iron with Varying Percentages of Aluminum*

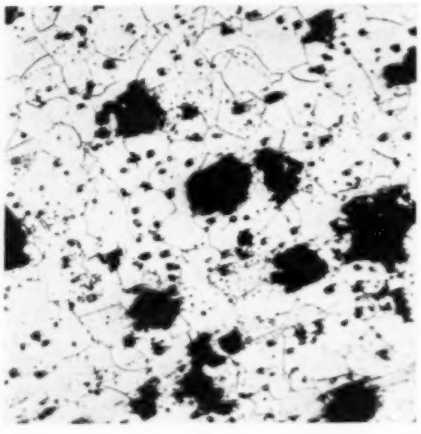


*Fig. 1—Malleable Iron Containing 0.036 Per Cent Aluminum. Etched with 2 Per Cent Nitric, 100 Diameters*

The hard iron, to which aluminum in varying amounts was added, was made in a 25-ton air furnace and one 800-pound ladleful of molten metal was used to pour 11 sets of test bars with approximately ½-inch diameter along a gage length of 2 inches, with 10 bars for each composition making 110 bars in all. The aluminum (containing 92.86 per cent aluminum) in the form of shot was thrown on the bottom of a 40-pound hand ladle, one of which was used for pouring each set of bars.

After finishing all sets and the necessary cooling, the bars were malleablized according to the following time-temperature cycle: Heating up to 1600 degrees Fahr., 19.5 hours; soaking period (above 1600 degrees Fahr.,) 26.5 hours; cooling period 1600-1200 degrees Fahr., 35.5 hours; and total cycle, 96.0 hours. The maximum temperature was 1710 degrees Fahr., and the average cooling rate from 1600 to 1200 degrees Fahr. was 11.3 degrees per hour. After the thermal procedure, the bars were turned to 0.504 to 0.506 inch in diameter and tested for tensile properties and bending. The remaining fractured halves were analyzed and averages of all the results embodied in the accompanying table.

Averages of chemical analyses made on metal without aluminum additions at the beginning and end of the experiments gave the following results: Total carbon 2.37 per cent; silicon 0.86 per cent; manganese 0.30 per cent; phosphorus 0.126 per cent, and sulphur 0.038 per cent. Aluminum additions to the molten hard iron resulted in various phenomena, discernible during pouring and solidification of the metal. While up to 0.08 per cent aluminum no difference in the behavior of the iron in ladle or mold was noticeable, increasing percentages developed first a larger amount of slag, which became sluggish until about 1.32 per cent aluminum was added. At that concentration also the metal commences to show decreased fluidity.

### Structures Are Normal

After malleablizing, the textures seem to show a certain parallelity with the previously described characteristics in pouring. Up to about 0.10 per cent aluminum the fractures appear quite normal. From 0.10 up to 1.00 per cent aluminum the fractures first become gray, then dull with irregular crystallization. Cold work

## Physical Properties

| Percentage of Aluminum (averages) | Tensile Strength lb./sq in. | Elongation in 2 inches per cent |
|---|---|---|
| 0.00 | 50,950 | 13.5 |
| 0.02 | 52,600 | 18.6 |
| 0.04 | 53,900 | 21.0 |
| 0.07 | 53,200 | 20.2 |
| 0.08 | 52 480 | 19.0 |
| 0.15 | 52,000 | 17.5 |
| 0.36 | 46,000 | 9.7 |
| 0.47 | 39,750 | 8.3 |
| 0.91 | 25,980 | 4.5 |
| 1.32 | 17,880 | 2.4 |
| 1.89 | 13,700 | 1.2 |

or physical stresses, as in tensile tests for instance, change the appearance into the so-called slaty structure. Thus, the transverse fractures of tensile test specimens appear somewhat radially acicular.

Microscopically the influence of aluminum upon the various constituents may be noted at concentrations exceeding 0.10 per cent aluminum. Excess of aluminum seems to change the ordinarily round globules of graphite into irregular more flaky shapes resembling the flakes of graphitic carbon in gray iron. Corresponding to these conditions a rapid decrease in all physical properties does occur.

Especially is this true for the elongation and reduction in area, which approach practically a nil value at concentrations exceeding 1.00c per cent aluminum. Experimental heat treatment of any imaginable combination, conducted with bars containing more than 0.5 per cent aluminum did not restore any of the physical properties of normal black heart malleable. On the contrary, the most surprising influence of aluminum was determined for concentrations not exceeding 0.05 per cent.

It has been observed repeatedly that a small addition, for example, from 0.01 to 0.05 per cent aluminum, had a marked effect especially upon the elongation and reduction of area, regardless of a well defined, but rather insignificant increase of the tensile strength. To prove that tendency definitely, experiments were repeated on other air furnaces as well as with hard iron made by the duplexing of cupola metal in the electric furnace. In all instances, influence of aluminum additions was noted.

# Investigate Binding Properties

By L. Wilson Greene

RELATIVE binding strengths of various fatty oils and their relation to linseed oil in this respect was the primary purpose of this investigation. As a secondary consideration, a comparison of binding strengths and iodine values was made to show that an analysis of a core oil does not predict its value as a binder.

Linseed oil has long been recognized as a good binder for sand cores. The baked cores made from this oil have good strength, satisfactory porosity and possess other valuable attributes. It was hoped that the study might reveal other oils of correspondingly high binding strength.

### Standardizes Procedure

To obtain strictly comparable results, it was necessary to standardize on core sand used, baking time and temperature, method of ramming cores and sand-binder ratio. Keeping these as constant as possible and varying only the kind of oil used, a definite comparison of resulting core strengths would be possible.

The sand employed was a high grade washed Ottawa sand, practically free from clay. Such a sand was chosen because of its uniformity and freedom from organic matter and other impurities. Well-mixed sand from the same barrel was used.

The cores were baked for 2 hours at 400 degrees Fahr. in a gas oven. The oven was indirectly heated and previous examination had shown that heating was uniform on the shelf upon which the cores were baked. The ratio of sand to oil was 50 to 1.

Hand ramming offers the only likelihood of appreciable error in these tests. All cores were rammed by one person and every operation was duplicated as closely as was humanly possible. A check was made for uniformity of ramming by weighing the baked cores and these were found to vary not more than 10 grams. Considering the varying amounts of oxygen absorbed during baking by the different oils, the small weights differences indicated that the method of ramming was sufficiently uniform for the comparison. The closely agreeing strength tests of the three cores made from each oil also attested to this. A hardwood core box was used and the cores were baked on a steel plate.

## Core Oil Tests

| Oil | Transverse Strength Pounds | Iodine Value |
|---|---|---|
| Raw Linseed | 47.12 | 186.0 |
| No. 3 Castor | 38.63 | 85.7 |
| Soya Bean | 37.00 | 130.0 |
| Chinawood (Tung) | 47.50 | 157.5 |
| Cottonseed | 31.00 | 109.5 |
| Mustardseed | 33.25 | 110.5 |
| Blown Rapeseed | 17.30 | 63.0 |
| Refined Menhaden | 38.00 | 156.0 |
| Blown Menhaden | 33.88 | 102.0 |
| Sperm | 22.75 | 85.5 |
| Herring | 23.00 | 132.8 |
| Cod | 31.40 | 151.0 |

Cores used for the tests were 12 inches long by 1-inch square. In the strength test the baked core was supported on two ⅜-inch steel rounds 10 inches apart, the latter being held in place by two uprights. A hook, also made from a ⅜-inch steel round, was placed over the central part of the core and a bucket suspended therefrom. Small lead shot were run into the bucket at a uniform rate until the core broke; the combined weight of shot, bucket and hook being taken as the load required for breaking. This was recorded as the transverse strength.

In the accompanying table the strengths represent the average of three cores, all rammed and baked at the same time. The strength tests were made after the cores had stood overnight. Average iodine values of each oil under consideration also are given.

From the experimental data an attempt was made to correlate the strength and iodine values by dividing the former by the latter. It will be obvious that nothing approaching a constant could be obtained in this way.

One interesting feature of the calculations was the relation between linseed oil with a high iodine value and castor oil whose iodine value is comparatively low. The figure obtained for linseed was 0.2533 and for castor 0.4507. The remaining ratios varied from 0.1732 for herring oil to 0.3311 for blown menhaden. All of the seed oils gave calculated ratios higher than that of linseed oil while the fish oils, except blown menhaden and sperm, had lower ratios. Sperm oil is, of course not a true fatty oil but a liquid wax and the high viscosity of blown menhaden probably explains its lower strength result.

### Confirm Other Observations

The above observations concerning the relation of transverse strength to iodine value bear out the conclusion of Prof. H. L. Campbell in *Transactions* A. F. A. 1925, that, "It is impossible to establish the value of any oil as a core binder on the basis of any chemical of physical property of the oil."

From an examination of the table here given, it will be noted that chinawood oil gives a strength just a little higher than that of linseed. However, the most interesting development of this investigation is that castor oil gives such a comparatively high strength. This is most unexpected since the oil is classed as nondrying. The only explanation that can be offered at this time is that baking evidently polymerizes castor oil, resulting in each grain of sand in the core becoming covered with a tenacious gummy film.

# Bearing Properties

## *Affected by Variations in Composition*

*By Clair Upthegrove*

BEARING metals may be classed conveniently according to the principal base constituent, as tin base, lead base, copper or copper-tin base, zinc base and aluminum and magnesium base. The oilless or oil carrying bearing metal must be added to these classes. Practically all classes with the exception of the lead base, are found in the automobile to some degree. The tin and copper-tin base alloys constitute the greater part of the regularly used bearing metals, the others representing only occasional or highly specialized uses.

### Limits Lead Content

Tin-base babbitt metal is used where comparatively high duty service is demanded, that is for main and rod bearings, although in the airplane engine its position appears to be threatened by the copper-lead alloy. Fairly wide variations are found in the babbitt metals used and recommended. Lead-base babbitt metal offers an equally serviceable metal at a much lower cost for many purposes but finds no use in the automobile. Lead is also limited in the tin base alloy to 0.35 per cent. This limitation is not due to any detrimental effect at atmospheric temperature, but to the fact that at temperatures appreciably above atmospheric, the effect of the lead is to soften the metal.

Failures in babbitt metal bearings are usually the result of a number of causes, such as flexing, pounding, softening or lack of proper lubrication. All of these may be considered as factors external to the babbitt metal, but the nature of the bearing metal must influence the response to the above factors. Factors which greatly affect the characteristics of the metal are: composition; pouring or casting temperature; and mold temperatures. To these must be added the method of manufacture or casting and the nature of the backing.

Society of Automotive Engineers specification No. 11 for babbitt metal recommended for connecting-rod and shaft bearings which are subjected to high pressure, has the following composition:

| | Per cent |
|---|---|
| Tin, minimum | 86 |
| Copper | 5 to 6.5 |
| Antimony | 6 to 1.5 |
| Lead, maximum | 0.35 |
| Iron | 0.08 |
| Arsenic | 0.10 |
| Bismuth | 0.08 |
| Zinc and aluminum | none |

### Constituents Vary

*DIFFERENCES in antimony and tin contents in tin-base babbitts cause variations in the structure of that metal, which is used for connecting-rod and shaft bearings in automotive engines. The effect of casting and mold temperatures and rate of cooling also exert considerable influence on the structure of that bearing metal. Bronzes are used more widely in the automotive industry than are babbitts. The selection of a bronze for worm gears and the effect of various constituents on the properties also are discussed in this article, which is an abstract of a paper presented at the Detroit meeting of the American Society for Testing Materials. The author is connected with the department of chemical engineering, University of Michigan, Ann Arbor, Mich.*

In view of the recent work of O. W. Ellis and G. B. Karelitz, *Transactions*, American Society Mechanical Engineers, 1928, it may be interesting to see what effect the permissible variations in composition as given in the specification may have on that alloy. In a study of the tin-base babbitt metals, a diagram showing the structural composition for the high-tin, low-antimony and low-copper alloys is shown in the accompanying illustration. An examination of the diagram shows that the limits selected are such that two distinct structural types are possible for metal compositions which conform to the chemical requirements. If the antimony or the antimony and tin contents are both on the low side, then no secondary SnSb is formed. If the antimony content is on the high side then the secondary SnSb is formed along with the primary CuSn, the delta solid solution and copper-tin eutectic. Perhaps this explains why some users of babbitt metal have found it more satisfactory to maintain their composition as 85 per cent tin, 7.5 per cent antimony and 7.5 per cent copper, thus insuring themselves of a constant type of structure as well as a slightly harder metal.

The effect of casting and mold temperatures has been considered by a number of investigators. Rate of cooling affects the sizes of the cubes of SnSb and may, if sufficiently rapid, suppress the crystallization of that constituent. According to Ellis and Karelitz that is more marked in alloys near the composition indicated by the boundary *BDF*. If the normal crystallization of the SnSb cubes is desired, it appears necessary that the composition be moved away from that boundary. If rates of cooling are always such as to bring about the suppression of the crystallization of the SnSb cubes, the possibility of the two types of structure disappears. If on the other hand the rates of cooling are not such as to insure suppression of the SnSb cubes, or if a structure with SnSb cubes is desired, it would appear that the present limits for the S. A. E. No. 11 alloy might well be modified to insure one type of structure.

### Copper Content Increased

The work of Ellis and Karelitz also is interesting in view of the feeling of some individuals that the copper content might profitably be increased at the expense of the tin. Increased antimony content is ordinarily associated with increased hardness. Similarly, increased copper content means increased hardness and better distribution of the SnSb cubes. The previously mentioned authors find that the hardening effect of increased antimony is not appreciable after the limit for the precipitation of the SnSb cubes has been reached. Conversely, the effect of the copper becomes more marked with antimony contents greater than the percentage at which the SnSb cubes make their appearance. However, the rise in hardness with increasing copper content is found to be less marked with

increasing temperatures. Increasing temperatures bring about a rapid falling off in hardness of practically all babbitt metals, but this appears to be more marked with the higher copper contents. The increased copper content also may affect the structure in a way other than from the appearance of the primary CuSn. Higher copper content apparently favors the growth of larger SnSb cubes. If the copper content is increased to 16 per cent, it is not evident how the bearing properties would compare with those of the lower copper content, except to expect that brittleness would be increased.

Centrifugally and die-cast bearings offer two variations from the production standpoint. In both, metal temperatures and mold temperatures have to be taken into consideration. In centrifugal casting the speed of rotation enters as an additional factor. Both appear to be satisfactory.

### Bronzes Have Wider Range

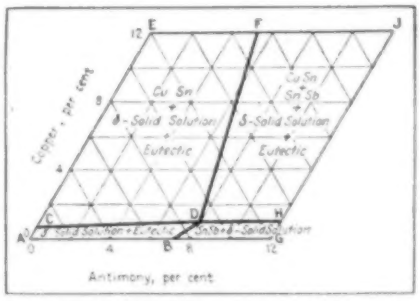
Bronzes find a much wider range of service in the motor driven vehicles than do the babbitt metals. Those commonly used show two constituents as cast, the alpha solid solution and the eutectoid of alpha plus delta. Where lead is added, it is found free as a third constituent. Increased percentages of tin result in a higher percentage of eutectoid and consequently a harder metal. Lead additions tend to increase the plasticity of the metal and as the bearing wears that element probably increases the amount of oil retained. Rates of cooling materially affect the structural characteristics of the bronzes. If chill cast, the eutectoid remains more finely dispersed than if cast in sand. On the other hand, if the rates of cooling were made exceedingly slow the hard eutectoid constituent would disappear entirely and a metal completely unsuited for bearing purposes would result.

Perhaps the most interesting application of the bronze as a bearing metal is in the worm gear. The chemical composition and the physical characteristics of the worm and the worm wheel must be such that the coefficient of friction is a minimum, also such that the minimum amount of wear takes place. The worm gear must resist high bending and compressive stresses. Ordinary bronzes, phosphor bronzes, aluminum bronzes and nickel-tin bronzes have been used for this purpose. Aluminum bronze, though capable of standing up under much greater loads than ordinary bronze, has not proved successful. The failure of aluminum bronze may be attributed to the fact that it does not compare favorably with the other bronzes as a bearing metal, being too hard, non-yielding and without sufficient difference betweeen its soft and hard constituents.

Experience has narrowed the composition range so that worm gears now produced generally fall within the following limits:

| | Per cent |
|---|---|
| Tin | 9 to 13.0 |
| Lead | 0 to 2.0 |
| Zinc | 0 to 2.0 |
| Phosphorus | 0 to 1.0 |
| Nickel | 0 to 4.0 |
| Copper | remainder |

As cast these alloys will all show the alpha plus delta eutectoid in a matrix of the alpha solid solution.




*Structural Characteristics of the Tin Rich Alloys of the Tin-Antimony-Copper System*

While the maximum strength of the bronzes is not reached below a tin content of 19 or 21 per cent, the amount of tin is limited by increasing brittleness. Therefore the composition at which the maximum hardening and strengthening effect may be attained without undue brittleness may be taken as 13 per cent tin. Phosphorus additions contribute in two ways to the bronze, first as a deoxidizer and second as a hardener, copper phosphide being precipitated with the alpha-delta eutectoid. Both Rowe, *Journal*, Institute Metals, vol. 36 and Comstock, in his discussion of the paper, believe that phosphorus should be added only as a deoxidizer and that hardening effects should be dependent upon the tin content. Lead additions do not appear desirable in that its effect is always to lower the load-carrying capacity. As the primary object of the addition of zinc is to improve the casting qualities, nothing is gained by the addition of zinc to a phosphor bronze.

The addition of nickel to the tin bronze has according to Comstock and Corse, in a discussion of the same paper produced beneficial effects. Corse presents in the accompanying table the results of five sets of bars of chilled gear bronze to show that nickel additions materially increase the strength and yield point without destroying the ductility.

It will be observed that the yield point remains practically constant after the addition of 1 per cent of nickel while the strength continues to increase with further additions of nickel. Comstock believes that when nickel is substituted for copper in a bronze the most distinctive effect is on the yield point, but when nickel is substituted for tin that a general improvement in the mechanical properties results. Nickel additions of 1 to 3 per cent will have an appreciable effect on the micro-constituents and as a consequence affect the hardness. This has been confirmed in the laboratories of the chemical engineering department of the University of Michigan, where considerable work has been done on the effect of nickel additions on the hardness of the microconstituents of the tin bronzes.

### Nickel Is Used

While the opinion of Comstock and Corse appears to be favorable to the use of the nickel in the tin bronze, counter views have been expressed by some users of this alloy. Service conditions are believed to have indicated that the presence of the nickel acts to increase the friction between the worm and the wheel in the inadequately lubricated condition. It is with considerable hesitation that a possible explanation for this effect is suggested. One of the desirable properties of a bearing metal is that it must wet readily with oils. In this case, if the actual effect of the nickel is to increase the friction in the inadequately lubricated condition, which may be assumed to be the moment of starting, then it would appear that nickel, while improving the mechanical properties, might also have the effect of lowering the degree to which the metal is wet by the oil. This in turn results in a lowering of the tendency to retain the oil film over the metal surface, a condition which favors increased friction at the time of starting.

It is believed that oil carrying metals will for some time be limited to light duty and in places where the maintaining of lubrication is more difficult. As a consequence the bearing metal qualities may be subordinated to the qualities favoring the maintenance of adequate lubrication.

The light-metal-base alloys, while

## Effect of Nickel on Tin Bronze

| Tin per cent | Nickel, per cent | Yield point, pound per sq. in. | Tensile strength, pound per sq. in. | Elongation in 2 in., per cent | Reduction of area, per cent |
|---|---|---|---|---|---|
| 10 | 0 | 24,900 | 37,500 | 5.7 | 5.2 |
| 10 | 1 | 32,700 | 39,100 | 3.2 | 2.2 |
| 10 | 1 | 31,000 | 44,200 | 7.0 | 8.3 |
| 10 | 2 | 31,000 | 47,200 | 7.2 | 8.0 |
| 10 | 3 | 31,600 | 48,300 | 7.7 | 8.3 |

apparently conforming in certain ways to the requirements of bearing metals, are limited in their application. Pistons of aluminum and magnesium-base alloys represent one type of bearing. The use of unbushed aluminum and magnesium alloy pistons also represents a practical application of bearing qualities. Magnesium-base alloys apparently show better bearing qualities if copper is present.

Aluminum alloys of the type of S. A. E. No. 34 are used for camshaft bearings and valve tappet guides. A suggested use for the aluminum-base alloy is as a bearing for nitrided steel.

# Centering Ingot Mold Cores

AT ONE time it was the almost universal custom to center the ingot mold core in the base, then close the cheek and afterward insert a steel bar in the top of the core barrel. This bar was employed to move the barrel sufficiently to center it at the top. In more recent years several methods have been introduced to fasten the core barrel to the base and thus eliminate pushing the core to the center of the mold. In one prominent Chicago plant the barrel is bolted to the drag. A collapsible barrel is used which can be pushed out with a special device which leaves the barrel in condition to be rammed again. It is not separated from the base. The mold pattern is mounted on a base which corresponds to the bottom. The pins on the base, match pin holes in the flask. The core-box is provided with lugs drilled to match the pins on the drag. Core-boxes and patterns are fabricated from cast iron.

### Cast in Four Sections

The corebox is cast in four sections, machined and bolted together and drawn off after the core has been rammed. Joints of flask and core-box are kept clean. A small amount of sand or dirt will throw the core out of center. During the drying period the mold is closed over the core with a 4-inch spreader between the bottom and cheek. Both are dried together. On the casting floor the cheek is lifted enough to remove the spreaders. Then the cheek is lowered and clamped in place and the mold is ready to pour.

The core barrel is made in two sections split diagonally, with one half containing the neck lifting section, also the foot to bolt it to the bottom. The other half is a floating section held to the first part by straight bolts. When pressure is put on the main half during extraction, the floating half gives a little, and allows the mold casting to be lifted from the barrel. This method involves a lot of construction of expensive rigging but where a company is making molds for its own use it would pay. In a jobbing ingot mold foundry this method is not practical on account of the wide diversity of patterns and the come and go habits of customers.

In a southern steel plant a jolt machine is employed to ram both core and cheek together. It is claimed that the method is economical for the number of molds—30 or 40—made per day. The barrel is keyed to the base by a big wedge. The base is a little different from the ordinary bottom. It has a deep flange projecting on the under side which enables the attendant to drive the wedge and still keep the wedge free from the jarr machine table.

The wood pattern makes cheek and core at same time. It is split diagonally and thus may be drawn off the core when the cheek is removed. The pattern is hinged and may be opened just a little. The various features of this process are patented. The barrel is loosened from the bottom after the casting is poured. It is of the collapsible type which collapses when the crane pulls up on the barrel. It must be wedged to the bottom to be used again. Bottoms and flasks are all machined to a jig and are interchangeable.

At a certain plant a large jolt machine originally designed for another purpose, has been adapted for making ingot molds. The core barrel is bolted to the bottom and mold and core are rammed together to the number of 12 to 15 per day. Further detail is of no interest since the installation probably never will be duplicated.

### Keyed to Bottom

At a prominent eastern steel plant the barrel is keyed to the bottom and mold and core are rammed together. They must come central when assembled the same as any three-piece job. The barrel here is solid, that is, it is in one piece. The bottom of the barrel carries a slot to engage a key that has an eye in it to wedge to the bottom. These wedges are removed after the molds are cast. After the molds are cool the barrels are pushed out or bumped out.

Some plants employ both methods. In the first, where the core is pulled over by hand, it is possible to get along with a smaller amount of equipment than the other way. In the second method where the core barrel is bolted to the bottom and where a combination pattern is employed to make core and cheek at the same time, every bit of equipment must be jigged to match. Comparing the solid and collapsible barrels the collapsible is the better. It is fastened to the bottom and can be extracted without bumping the barrel.

A large midwest mold maker uses an extra large base on the foot of the core barrel. This forms the bottom of the mold at the same time the core is rammed. This feature is known as a sand flange and reliance is placed on the large bearing surface to hold the core central.

The core barrel when rammed is set in a master bottom and the box is hinged, jigged, etc. Patterns also are jigged, so everything must match. Patented collapsible barrels are used at this plant.

At a prominent steel plant in the Pittsburgh district the barrel is not fastened to the base. The core is rammed with the barrel setting in a master base identical to the bottom of the mold. This makes the centering of core an easy matter.

## Cost Men Hear Grover

Albert E. Grover, cost consultant, National Machine Tool Builders' association, Cincinnati, addressed the New York chapter, National Association of Cost Accountants at its regular monthly meeting held Dec. 9 at the Builders' club, New York, on how the machine tool building industry has benefited from uniform cost accounting. Mr. Grover described the manner in which a uniform cost system was introduced and outlined the results. He introduced his subject with a discussion of standard costs, the use of uniform cost methods and system installations. The speaker also commented on the special service an association may render its members through the preparation and introduction of a cost system thoroughly adapted to the particular needs of the industry it represents.

## Tool Makers Merge

Ray Machine Co., 5403 West Lake street, Chicago, manufacturers of electric screw driving, nut setting and tapping machines, has been merged with the R. G. Haskins Co., 4630 West Fulton street, Chicago. The latter company will continue to manufacture those appliances formerly made by the Ray company. W. H. Ray will be associated with the Haskins Co.

Modern Pouring Device Co., Port Washington, Wis., has changed its name to Modern Equipment Co.

# Liquid Metal Is *Pressure-cast* into Steel Dies

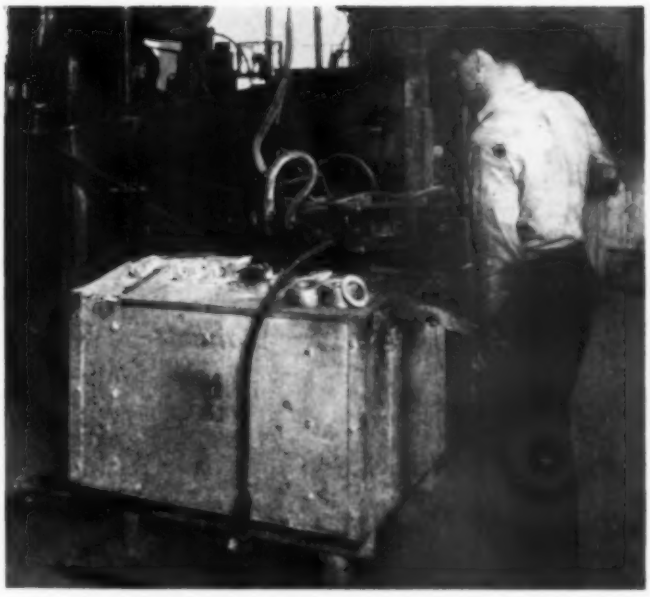


*Fig. 1—This Simple Machine Will Turn Out 5000 Lead Washers a Day*

MATERIALS other than sand first were used for molds in which to cast metals in the dim and distant past. Discoveries and the excavation work by antiquarians have brought forth stone and pottery molds in which castings were made as early as 1000 or 2000 B.C. However, it appears that it was not until early in the fifteenth century that the use of metal molds was instituted. This step is attributed to the rapid progress which had been made in type founding methods.

Excellent results obtained with metal molds led to further developments in their use and at present that type of mold is used in five different processes of producing castings. These include permanent mold casting; slush casting; centrifugal casting; the Cothias system, and die casting. While these processes are similar in that all use a metallic mold, it may be well to point out the essential differences in the various methods.

### Thin Shell Remains

In permanent mold casting a close-grained gray iron mold is used and the metal is poured by *gravity*. This process is employed in the production of pistons, kitchen utensils, etc., cast in aluminum alloys; gray iron castings; brass and bronze bearings, aluminum bronze castings, etc. Molds for slush casting generally are made of brass or bronze and the alloys employed are zinc-base or white metal. The molds are open at the top and the molten metal is poured into that opening. The metal is allowed to remain in the mold for a certain period until a thin shell of metal next to the mold surface has solidified. Then the mold is inverted, and the still liquid metal in the interior is returned to the melting pot.

Molds for centrifugal casting generally are made of alloy steel. They are placed in suitable machines with driving mechanisms which cause the mold to rotate in a horizontal or a vertical plane. The centrifugal force exerted by rotation of the mold throws and holds the metal to the wall of the mold until it solidifies. This method of casting is used for production of hollow cast iron pipe; hollow brass and bronze bushings, bronze gear blanks, and gray iron piston ring pots. The Cothias process employs a cast iron mold in two parts corresponding to the cope and drag of a sand mold. The cope or top mold contains the cores which usually are steel, and the drag or bottom mold conforms in shape to the desired outside shape of the casting. Just enough metal to make the casting is poured into the lower half and then the upper half is forced down mechanically into the lower half similar to a stamping press. This action forces the liquid metal into all corners of the two parts forming the mold. This process has been used for production of automotive castings in England.

Die casting is distinguished from the previous processes in that pressure is used to force the molten alloy into the metal mold or die. The dies usually are made of chromium-vanadium steel or other special alloy steels called die steels. Pressure to force the alloy into the die is supplied either by a piston or by compressed air. Alloys used for die casting usually are tin-rich, zinc-rich and aluminum-rich. Higher melting point brasses and bronzes may be die cast but the erosive effect of these alloys on steel dies has been so detrimental as to preclude commercial use. However, recent reports indicate that brass die casting is being performed successfully.

### Type Cast in Metal Molds

Probably one of the first machines devised to employ the principles of die casting was that invented by Bruce in 1838. This machine was developed for casting or founding metal type for the printing industry. In 1855 Mergenthaler perfected his linotype machine which employs recognized principles of die casting. One of the first machines of that type to be used for other than the casting of type was that patented by C. and B. H. Dusenbury in 1877. This machine was developed for the express purpose of making babbitted bearings. The machine contained a cast iron cylinder and piston which were immersed in the molten metal. Pressure on a lever caused the piston to act and force the molten metal into the bearing.

### Three Features Essential

Further application of this principle appears to have laid dormant until about 30 years ago, or to be exact in 1902 when Underwood developed a machine for producing die castings. In 1907 Doehler perfected his piston type machine and in 1910 developed the application of compressed air for forcing molten metal into the die. The essential features of the process are a metallic mold or die capable of withstanding erosive action of the molten metal or alloys as well as sudden temperature changes; an apparatus or machine which will deliver the molten alloy into the mold or die under sufficient pressure to fill every impression in the mold and give a perfect casting, and an alloy of suitable composition for the work.

Die casting essentially is a process for quantity production and usually is not applicable to work in which less than 5000 castings are desired. This is due to the heavy expense of die preparation which must be distributed over the resultant product. Consequently, the greater the number of pieces that can be produced from a die, the lower is the die cost per piece. This may be seen easily when it is pointed out that die costs run from $400 to $1200 and in some instances up to $3000. Although die castings require little or no machining, it is apparent that on a commercial basis, the ultimate cost of any die casting must be equal to or less than

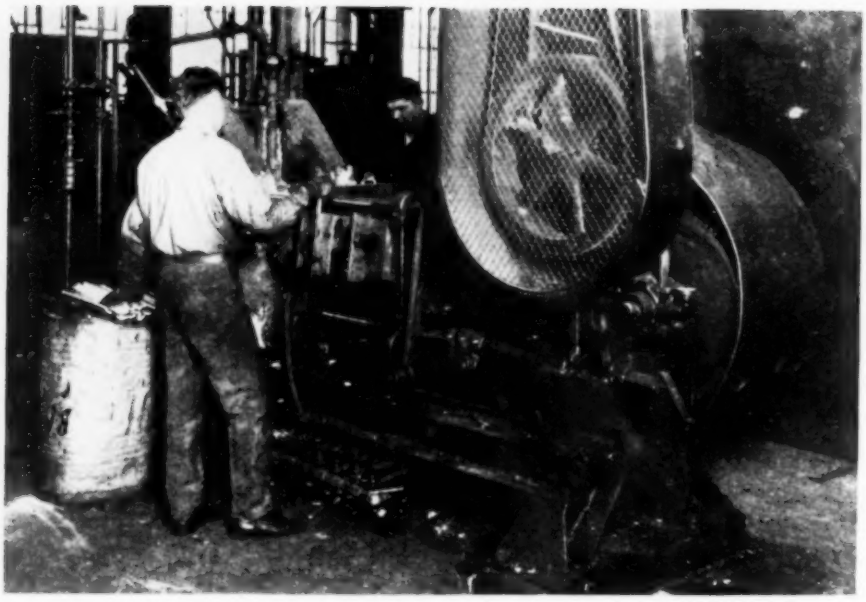


*Fig. 2—An Ingenious Arrangement of Levers and Toggles Open and Close the Die and Eject the Casting*

the cost of a sand casting plus the added cost of machining.

The principal advantages claimed for die castings are that they are accurate and uniform. Machining costs either are eliminated or reduced greatly. The process of die casting is continuous and the output usually is rapid. One of the main functions of die casting is to save machining costs, and where these are not important, die castings ordinarily are not made.

While only a few firms were engaged in the die casting industry in the early days, remarkable progress has been made and today over 60 firms are a part of that industry. The field of work has enlarged from a few types of tin, lead and zinc-base alloy castings to an almost infinite variety of these alloys and aluminum-base alloys used in a large number of industries including the automotive, camera, player piano, phonograph, electrical, radio, etc.

### Die Making Important

As in any other type of foundry, die casting plants are arranged so that a straight-line flow from the raw material to the finished product is maintained. While not a hard and fast rule, most die casting plants are in two or three-story buildings. The die casting department proper usually is located in the upper story with the remaining floors of the building containing the heat treating furnaces for dies, the machining and finishing departments, polishing and plating departments for applying nickel or chromium finishes, shipping department, engineering department, etc.

Die making is one of the most important phases of the die casting process, often requiring many men and a variety of machines as shown in Fig. 5. The department illustrated is equipped with various types of machine tools capable of the finest adjustment. Necessity for such tools is understood when it is realized that the various parts composing the die must fit with the utmost accuracy. The finishing operations on the dies usually are carried out under magnifying glasses to insure the highest perfection of the surfaces. Such surfaces are required because the molten metal injected into the die at pressures ranging from 250 to 450 pounds per square inch will retain even the slightest imperfection. Loose fits may allow metal to creep into the joints and cause difficulty in removing the castings.

Another reason for close finish on die work is the rigid specification which the die casting must meet. For example, the United States army ordnance specification for die castings include data on the allowable maximum weight of individual castings, minimum wall thickness, minimum size of cast holes, maximum number of external threads per inch, and the draft on cores and side walls of the castings.

Fig. 3 shows a battery of machines used by one manufacturer to produce zinc-base die castings. The machines are the vertical type, that is to say, the die when it is being filled is above the injector nozzle, and the metal is forced upward into the die. The metal pots are gray iron and heated by four gas burners. These burners sometimes are assisted by a fifth which plays on the surface of the molten metal. The die is attached to a frame which is hinged at one end of the heavy cast iron plate forming the top of the melting furnace. This hinged arrangement permits swinging the die in an arc from the vertical or pouring position to the horizontal or opening position.

The frame containing the die is counterbalanced by weights attached to it by ropes passing over pulleys. Two men operate each machine for while the die is counterbalanced, much effort is exerted in swinging the die from one position to the other. Also it would require considerable time for one man to perform the various operations of unlocking the die, opening it, backing out the cores, and ejecting the castings. As usually arranged in this type of vertical machine, the drag part of the die is uppermost when poured. The cope containing the gate which makes contact with the injecting nozzle, forms the bottom of the die.

### Gives Operating Cycle

In operating one of these machines, the cycle is as follows, assuming that the frame and die are in the horizontal position with the die open. If the drag is composed of several moving parts or contains cores, the various levers controlling these parts are moved until the parts are in the proper position for receiving the molten metal. Then the drag is forced tightly against the cope by a long lever and locked into position by bars

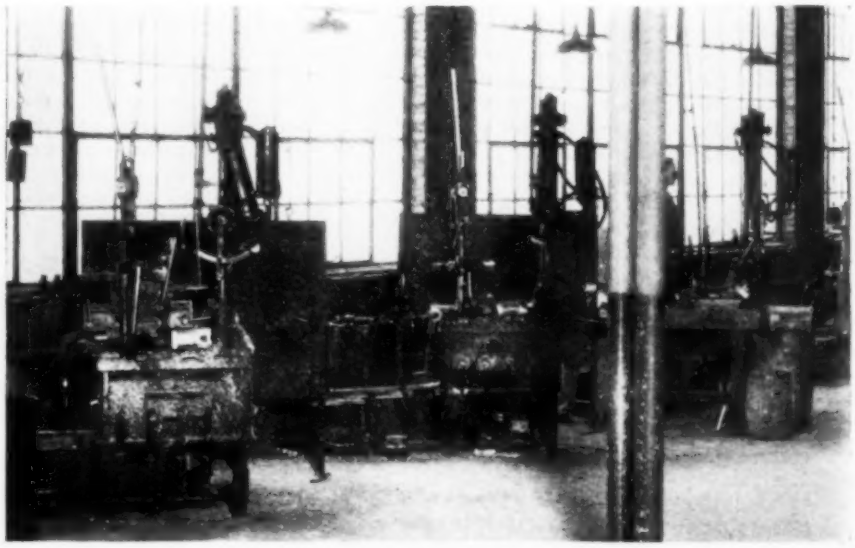


*Fig. 3—Zinc-base Die Castings Are Made in These Hand-operated, Vertical-*

wedged into slots in pins which project through the drag. When all is secure, the frame and die are swung into the vertical position which causes the gate in the cope to fit snugly against an opening in the heavy plate which forms a partial cover over the melting pot.

One of the operators opens the air valve to an air piston controlling the injecting nozzle. As the air is admitted, the nozzle full of molten metal is raised above the surface of the metal in the pot and seated against the gate in the die by the action of an arm connected to the air piston which is above and at the back of the machine. When the full force of the piston is exerted, the end of the arm which fits into a sleeve in the nozzle is forced into the nozzle and creates the necessary pressure to drive the molten metal from the nozzle into the die.

*Fig. 4—Aluminum-base Alloys Are Melted in Separate Furnaces*

### Castings Are Inspected

Since the metal sets almost at the instant it strikes the die surface, the air valve is released after a few moments. This permits the arm to withdraw and bring the nozzle below the surface of the metal in the pot. The frame and die are swung into the horizontal position and the die unlocked by removing the bars in the slotted pins. The drag part of the die is separated from the cope through the action of the long lever which previously was used to bring the two parts together. The moving parts of the drag and the cores are backed away from the casting which is removed by one of the operators. The operator breaks off the gate and part of the flash at the joint and inspects the casting for obvious flaws. Defective castings are returned to the melting pot and the good ones are transported to the trimming and finishing department.

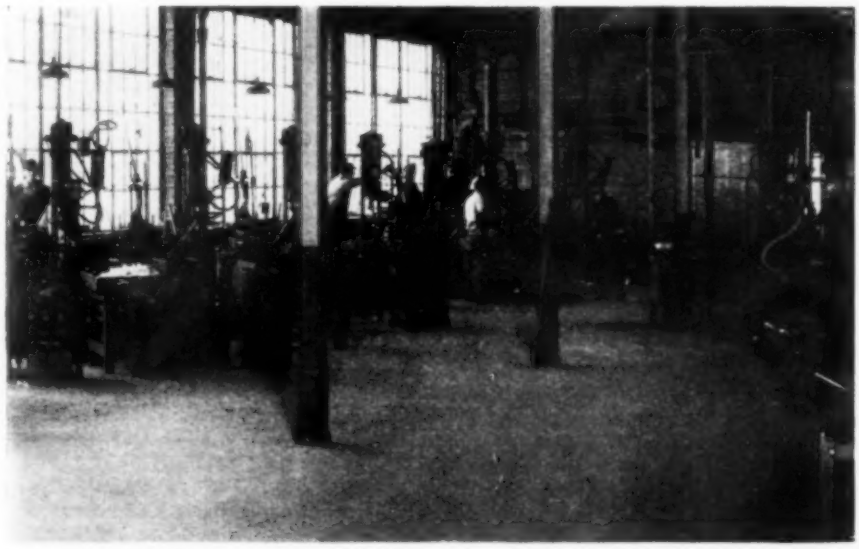
A slightly different type of machine is used by some to produce die castings from aluminum-base alloys. These machines may be considered as vertical in type, but they differ in operation from the zinc-base machines in several ways. The metal pot in the aluminum-base machines is placed above the pot and the metal is ejected down into the die. The dies are mounted on a flat table which is moved back and forth through the action of a rack and pinion. The machines operate under approximately 250 pounds per square inch air pressure and are equipped with small alloy cast iron metal pots, which are heated with gas. Since aluminum-base alloys have a much higher melting point than the zinc-base and tin-base alloys, it is not feasible to melt the metal in the pots in the die casting machines. One type of furnace which is used for that purpose is shown in Fig. 4. The pots are alloy cast iron and have capacities from 250 to 275 pounds. The pots may be arranged behind the die casting machines.

Horizontal die casting machines also used for aluminum base alloys, are similar to that shown in Fig. 2. These machines have metal pots containing about 150 pounds of molten metal and operate under an air pressure of approximately 450 pounds per square inch. These machines may be designed either for semiautomatic or automatic operation. The machine shown in Fig. 2 is semiautomatic in operation. As may be seen the movement of the cope and drag parts of the die, and the movement of the whole die to the injecting nozzle is accomplished through an ingenuously arranged series of levers and toggles which are driven by an electric motor through a gear at the back of the machine.

### Cores Moved by Cams

Although this motion is entirely automatic, the adjustment of the various moving components of the drag part of the die and the cores is made by hand. In the full automatic machines, the latter operations are performed by the machine. Operation of the cores often is of interest. For example, a particular die developed by one company to make a part of a vacuum cleaner contains six steel cores. In its position in the machine, two cores are located in each of the two sides and one in the top and one in the bottom. Cam actions actuated by motion of the machine cause the cores to slide in and out of position.

In the full open position, the drag and cope parts of the die are separated and the cores are withdrawn. When the machine is thrown into gear the drag portion of the die starts to move forward. As it does, the cam action slides the cores into position. The drag moves slowly forward and meets the cope and the two parts automatically are locked together. The whole die then moves forward to the nozzle which is filled with molten metal. The nozzle is seated on the gate opening



*type Machines. Splash Guards between Machines Protect the Operators*

in the cope. This seating takes place at the end of the forward movement of the die, and at the same instant the piston in the nozzle is forced down causing the metal to be injected into the die.

Shortly after this the return motion begins, and the die is drawn back slowly. Both parts of the die move back together for a distance of about 18 inches, when motion of the cope ceases and the dies are unlocked automatically. The drag continues to move back slowly and the cam actions withdraw the cores from the casting. As the drag reaches the end of the backward stroke, the ejecting pins come into play and force the casting from the die. Then the drag begins its forward motion for another cycle. While the description seems to indicate a rather simple device, considerable painstaking work was necessary to synchronize all movements so that the operations and cooling conditions are uniform.

*Fig. 5—Accurate and Painstaking Work in the Die Making Department Are Reflected in the Castings Turned Out*

An example of a simple die casting machine for casting lead-base thrust washers for an automobile is shown in Fig. 1. Each die contains two impressions and turns out two washers. These dies, as may be seen, are water cooled. An operator on one of these machines can turn out approximately 5000 washers in a day.

## Gray Iron Has Valuable Engineering Properties

(*Concluded from Page* 64)

experiments covered the action of steam up to 850 degrees Fahr. and the atmosphere from 1100 to 1850 degrees Fahr.

J. E. Hurst, *Foundry Trade Journal* Aug. 12, 1926, points out similarity of the growth phenomena to the spalling tendencies of refractory materials. It has been found that spalling tendency is directly proportional to the coefficient of expansion and inversely proportional to the diffusivity (of temperature) and a strength factor. Hurst believes that the growth tendency may be found inversely proportional to the maximum strain or inversely proportional to the maximum strength and directly proportional to the modulus of elasticity.

In other words irons of low strength which are stiff are most likely to form cracks during the reversals of heating and cooling. He points out that Mellanby stated that resistance to wear and resistance to growth are directly proportional and that Donaldson found the maximum resistance to growth in irons having the highest tensile strengths through the ranges of temperature studied. Hurst qualifies that internal oxidation is a factor in growth, although a secondary one.

In the experiments of Schwimming and Flossner, *Stahl und Eisen*, 1927, cycles were 400 to 1200 degrees Fahr. They found no evidences of growth below 850 degrees Fahr. At 1020 degrees Fahr. growth starts slowly at first, but after about 10 heatings it increases rapidly and approaches a limit. Their microscopical evidence indicated that the initial changes were due to slow breaking up of the cementite lamellae of the pearlite. The latter stage shows decomposition of the cementite and subsequent agglomeration of fine graphite to the coarse flake form. At 1200 degrees Fahr. the change is much more rapid only 4 heatings being necessary to completely decompose the pearlite. The irons used contained 3.32 to 3.68 per cent carbon, 2.47 to 2.75 per cent silicon, and phosphorus, 0.13 to 0.83 per cent. In the highest phosphorus iron it was observed that the pearlite located near the steadite structures resisted breaking up for the longest period.

## New England Founders Hear Truxell

Fifty foundrymen attending the regular monthly meeting of the New England Foundrymen's association held Dec. 10, at the Engineers club, Boston, heard an instructive address by W. N. Truxell, foundry engineer, Potter Coal & Coke Co., Greensburg, Pa., on "The Metallurgical Advantage of Higher Melting Speed."

After the meeting was called to order by the president E. F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass., the members were informed of the death of Dr. Moldenke. In addition to paying tribute in the meeting, a committee composed of R. F. Harrington, Hunt-Spiller Mfg. Corp., Boston; Walter M. Saunders, Providence, R. I.; and Charles A. Reed, Rogers, Brown & Crocker Bros. Inc., Boston, was appointed by the president to draft resolutions.

The president also appointed a committee consisting of three past presidents to nominate officers and members of the executive committee for the following year. The committee is composed of A. B. Root Jr., Hunt-Spiller Mfg. Corp., Boston; R. F. Harrington, Hunt-Spiller Mfg. Corp., Boston; and Charles F. Miller, Universal Winding Co., Providence, R. I. Arrangements for the annual meeting were placed in the hands of a committee composed of Charles A. Reed and Fred F. Stockwell, secretary of the association.

# *Advises* Basing COSTS on 50 Per Cent *Operations*

## *Arthur Simonson Tells Steel Founders To Use Old Basic Formula that Total Cost Plus Profit Equals Selling Price*

NECESSITY for a sound basis in establishing the selling prices of steel castings was emphasized at the sessions of the Steel Founders' Society of America, Inc., at the Hotel Sherman, Chicago, Dec. 10, 11 and 12. The campaign was started for a more general adoption of the organization's new accounting and cost plan.

It was voted that the society proceed with a survey to determine the distribution by classes of the sales of steel castings shipped in the last normal year by states and by industrial fields. This action was taken in adopting the report of the statistical committee which recommended the survey. A separate study identical in scope, is to be carried on for the heat-corrosion resistant alloy castings, and regular reports are to be made. It is intended to present a complete picture of the geographical sales of castings as well as their use in industrial groupings, with the aim of simplifying some of the merchandizing problems and providing an economic balance of sales. Attendance was fair and several new memberships were reported.

Arthur Simonson, Falk Corp., Milwaukee, was chairman of the first general session, which included an introduction by President John E. McCauley, of the society, and reports of committees. Granville P. Rogers, managing director, gave a progress report in which he outlined the comprehensive work of the organization in many lines. He pointed out the alloy freight rates are being handled satisfactorily.

Mr. Simonson spoke with force on poor management and selfishness that permits disastrous price structures, spelling trouble for any industry. He stressed the importance of accurate cost knowledge.

"For at least the time being we need to forget about the excess capacity that exists and base the cost of operating our plants on a figure approaching 50 per cent," he said. "If we base our costs upon some theoretical percentage of operations instead of that which actually exists, we are only fooling ourselves.

"In the desire to get volume of business instead of business at a profit, we have lost sight of that simple equation which should be the basic formula of every manufacturer —total cost plus profit equals selling price. We must get back to that first principle before we are on a sound basis. We have made ourselves a laughing stock to the purchasers. It has come to a point where some of the purchasers who have a good knowledge of values are almost apologetic in turning us down.

"The buyer is willing to pay a fair price, and while we all speak of a buyers' market, could that mean a disastrous market for the seller if we were not so spineless as to permit it? Could the conditions which exist today continue if we had backbone enough to say we will not do business except at a profit? It is clear evidence that we do not know our costs, for one thing. Competing bids vary by a minimum of $5 a ton, and anything for maximum.

Arthur Simonson

"It is true that we are suffering from business depression, but is it not true also that the situation is badly aggravated by our mental attitude toward it? I believe the figures show that our business as a whole, that is the steel foundry industry, was in a little worse shape in 1927 and a lot worse shape in 1921, but there was a distinctly different attitude at that time.

"Let us bear in mind that we are in a fundamental industry, and our product is one which the world is going to need for many years to come. For something which is requisite, just as food and clothing are, the world is willing to pay a price which insures continuity of supply, and this continuity of supply can only be insured as a result of profits made.

Dr. Ansel St. John, president of the St. John X-Ray Service Corp., New York, spoke on X-ray inspection in metal industries, describing x-ray technique.

The large castings division held a forum on the best method to interest the group in putting into service generally the accounting and cost plan of the society, adopted last February. Discussion was led by J. T. Osler, president, the Continental Steel Roll & Foundry Co., East Chicago, Ind. T. H. Harvey, Ohio Steel Foundry Co., Lima, O., was chairman. Profits per dollar necessary in the large castings business also were considered. It was pointed out that about a dozen in the membership have added the society's cost system, which is being installed in six to twelve weeks, and that the system actually is representative of production conditions. Its successful application, it was emphasized, depends upon breaking down the costs and accounting methods to cover accurately all divisions and units of the foundry organizations. James L. Palmer, professor of marketing, University of Chicago, addressed the small castings group, with L. S. Peregoy, Sivyer Steel Casting Co., Milwaukee and Chicago, as chairman.

A luncheon session was addressed by Lee E. Ragsdale, superintendent of the Western Union Telegraph Co., Chicago, on "Communication and Its Relation to Business."

A session of the heat-corrosion resistant alloy founders' division also was held under the chairmanship of Thomas R. Heyward Jr., Duraloy Co., Pittsburgh. The annual meeting of the Electric Metals Association, Inc., also was held in connection with the society sessions.

# Questions & Answers on FOUNDRY PRACTICE

GRAY IRON

## Metal Molds Are Used

QUESTION

Can you give me any information on permanent molds? Also what kind of wax is used in statuary work?

ANSWER

From time to time articles have appeared in THE FOUNDRY on the use of permanent molds for making gray iron, bronze and aluminum alloy castings. The most recent application is that for producing malleable iron castings which was described in the March 1 and March 15, 1930 issues under the title "Cupola Malleable Is Cast in Permanent Molds," by H. W. Hyde. The molds usually are made of a dense gray iron with fairly heavy walls to withstand the alternate heating and cooling which takes place. Marius in the Aug. 15, 1929 issue of THE FOUNDRY states that the heavier the walls of the mold, the longer they last. He also mentions that if the mold walls exceed a temperature of 850 degrees Fahr. during pouring the life is less than with heavier walls which can absorb more heat without allowing the temperature to exceed that mentioned. However, the walls of the mold should not be so thick that they cannot be handled in machining and on the foundry floor.

Considerable experimental work will be necessary to determine the location and size of the gate. Also it may be necessary to provide vent channels at various points to carry off the gases and air. If the casting is simple, a two part mold may serve, while if complicated a multipart mold will have to be designed. Whatever the number of parts, all joints will have to be fitted carefully so that they may be taken apart and put together easily, and leave no openings through which the molten metal can creep. Considerable ingenuity will have to be displayed in clamping the parts of the mold together as some *give* has to be allowed. One company is engaged in the design and construction of permanent molds commercially which employ a refractory lining for a metal mold.

In your inquiry about wax for statuary work, we presume that you mean wax such as used for the lost wax process. Beeswax alone may be used, but usually it is hardened with rosin, or ceresin. Try 2 beeswax and 1 rosin, or 7 beeswax and 3 ceresin.

**THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:**

**John H. Hall**
**Cast Steel**

**H. A. Schwartz**
**Malleable Cast Iron**

**J. W. Bolton**
**Gray Cast Iron**

**All questions should be addressed to the Editor, The Foundry, Penton Building, Cleveland.**

Q & A

## Iron Resists Rust

QUESTION

Have you any information on rustless cast iron? We have to make some heavy cylinders that are to operate with water pressure and the rust must be reduced to a minimum, or entirely if possible.

ANSWER

It is not evident from your question whether you have in mind a truly rustless cast iron, in the sense that stainless steels are rustless, or whether you are interested in a regular gray iron of maximum rust resistance. Also it is not clear what sort of cylinders you have in mind. No regular gray irons are rustproof, but their rusting or water corrosion is lower than that of many ferrous metals. Practically all ordinary steels, either straight carbon or low alloy, rust more readily than gray iron. Commercially pure irons which are sold under trade names, resist rusting much better than ordinary steels, but they are not rustproof. Wrought iron is rust resisting but not rustproof.

Stainless steels and irons containing from 12 to 14 per cent and upward of chromium, can be obtained in grades which not only are rust resisting, but when properly heat treated and polished, are truly rust-proof. However, many easily rusting steels are protected from rusting by galvanizing or other protective coatings. Special types of cast iron containing high percentages of chromium have been made rustproof. However, these metals are expensive and difficult to machine. Ordinary grades of gray iron are made practically rustproof by use of protective coatings. Although ordinary grades of gray iron are not rustproof, they are sufficiently rust resisting to find extensive applications where water is encountered. Different grades of regular gray iron apparently do not vary greatly in their susceptibility to rusting as is indicated in the bureau of standards soil corrosion studies, and in papers presented at the 1929 meeting of the American Society for Testing Materials.

A good, close-grain metal suitable for your service from a mechanical point of view, probably will be sufficiently rust resisting for the work you have in mind. Motion of the piston will keep the rust down and lubrication if present will help materially. If the water is slightly alkaline, the rust will not amount to much. If it contains a great deal of

oxygen and free carbon dioxide, the water will be more corrosive. If the water is definitely acid, it may be seriously corrosive.

A recent development in the field of corrosion and heat-resisting cast irons is the use of about 20 per cent monel metal in the charge, and additions of up to 3 per cent chromium in the molten metal. The copper and nickel in the monel metal, and the chromium aid in increasing the rust-resisting qualities of the iron.

Q & A

## Gives Radiator Data

QUESTION

Have you any information on mixtures that will be suitable for cast iron hot-water stoves and radiators? These are made in sections which must withstand a water presure of 90 pounds per square inch on the testing stand. Are any special measures to be taken in view of the sulphur and phosphorus contents and the casting temperature? Is it necessary to use any special pig irons?

ANSWER

The analysis for hot water stoves and radiators depends somewhat on the metal sections. To insure maximum heat transfer such castings usually are made as light as possible. The requirements then are good fluidity, reasonable strength and as a rule, ready machinability. Consequently to obtain the best results, good hot iron is needed. That in turn means good cupola operation and rapid handling of ladles. Good cupola operation does not consist of using heavy coke ratios. Too much coke between charges often means dull iron. With a bed charge 30 to 42 inches above the top tuyeres, not over 30,000 cubic feet of air per ton of iron melted, and not over a 1 to 8 coke to iron ratio in the charges, good results should be obtained.

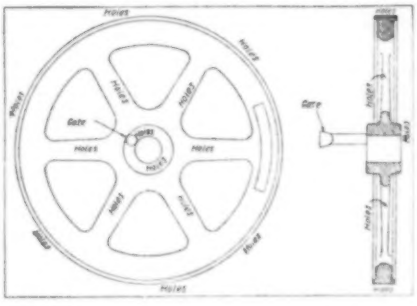
Care should be used in coke selection. A low-ash, fast-burning coke of firm structure gives the best results. Local inquiry probably will indicate the best grades available. A 90-pound water test is not high so the metal need not be a so-called high test iron, but it should have a fine, dense grain. It may be advisable to use a small percentage of steel scrap, say 5 to 10 per cent, as that usually produces a denser metal freer from shrinkage. Some radiator manufacturers use iron (at the spout) containing 2.20 per cent silicon and about 0.65 per cent phosphorus. However, higher silicon irons (2.50 to 2.60 per cent) with lower carbon (3.30 to 3.40) are quite fluid and have good mechanical properties. If handled quickly such irons will run light sections if the flow or travel is not too long, even though the phosphorus is 0.30 and under. However, in radiator work, the travel usually is long and it is likely that high phosphorus say around 0.70 per cent will not only be desirable, but necessary. Sulphur should not be high. By using a good grade of coke you should be able to hold the sulphur at 0.100 per cent or under. Manganese may range from 0.50 to 0.80 per cent. It is unlikely that special or fancy irons will give improved results if cupola practice is good and the analysis is adjusted to the work in hand. Since the metal thickness in cast iron boilers is considerably heavier than that in radiators, the silicon will have to be reduced to prevent leakage. Silicon around 1.70 per cent is suggested for the heavier sectioned castings.

Q & A

## Defects Caused by Gas

QUESTION

We have forwarded to you several sections of castings showing an extremely porous condition, and a sketch showing the locations of the porous spots on a flywheel. The porous condition we believe is due to the addition of copper in the pig iron charge. The copper was added intentionally by incorporating a scrap automobile generator with the cylinders in a charge. The generator contained about 6 pounds of copper wire and was added to a 1000-pound iron charge. The analysis of the cupola iron shows: Silicon, 2.32 per cent; sulphur, 0.061 per cent; phosphorus, 0.236 per cent; manganese, 0.58 per cent, total carbon, 3.32 per cent, and copper, 0.14 per cent. We have added 2 per cent copper in the ladle experimentally but it does not appear to affect the metal as shown by one of the samples. We do not believe that our molding practice or melting is at fault as no trouble is encountered when the generators do not enter the charge.




*Oxidized Iron May Cause Holes at Points Indicated in Casting*

ANSWER

Your difficulty is what usually is known as blow holes or gas cavities. The gas may be in the molten metal coming from the cupola and freed when the metal freezes. In that case the source of trouble probably is in the cupola melting. An excess of blast and a lack of proper balance between iron charges, coke charges and air volume are the common sources of trouble. We rather believe that you are using too much air because with your silicon, carbon usually is considerably higher than 3.32 per cent—providing that the mixture does not contain a high percentage of steel. If your iron is dull and sluggish, it quite likely has been oxidized as outlined previously or from the use of poor materials such as steel flashings, rusty scrap, etc.

Dull iron poured into wet, hard-rammed molds sometimes causes similar blowholes. It is hard to believe that 0.14 per cent copper is the source of your trouble. Copper is soluble in iron only to a limited degree, yet metal has been observed with copper so high that it showed up in the fracture as inclusions, and as bright copper spots on the machined surface—but no blow holes were observed. If the copper from the generators was oxidized, that in itself would indicate poor cupola practice.

Therefore, it is suggested that you investigate your cupola practice and see that your charges of iron are commensurate with the diameter of the cupola. While apparently you do not have trouble, it may be that you are operating on the edge, and any slight changes in the materials charged may be enough to throw the balance the other way. After deciding upon the proper iron charge, use coke splits in the ratio of 1 coke to 10 iron. Air should be supplied at the rate of approximately 30,000 cubic feet per ton of iron melted. Knowing the amount of iron melted per hour in your cupola, you can figure out the amount of air to be supplied per minute.

GENERAL

## Hole Caused by Blows

QUESTION

We are forwarding a ring about 14 inches in diameter with which we are having trouble indicated by the honey comb appearance in one place. We feed with three runners in a V-shape and use a block-skim gate with risers. Our mixture is made up of 350 pounds of pig iron containing not less than 3.25 per cent silicon; 200 pounds of gates and 50 pounds of scrap. These rings must be soft.

ANSWER

Careful examination of the defect indicates that it is caused by a blow resulting from either hard ramming, wet sand etc., at the particular point. The remainder of the casting appears to be all right, and has a nice smooth skin. If a swab is used, it may be that the molder is a little careless and allowed too much water to dribble on the sand. While it may be caused by hard ramming, it hardly seems pos-

sible that it would occur at only one small place, especially with a symmetrical pattern without portions projecting above or beyond the remainder of the pattern. Blows also may be caused by pieces of scrap imbeded in the mold at the surface or near the surface or face of the mold. Another cause may be balled sand, that is to say lumps of clay which are covered with sand. Such lumps when near the face of the mold cause blows through obstructing the passage of gases from the face or through evolution of steam from the contained moisture.

While you do not state, it is possible that the castings you make are made by what is known as the multiple molding method where the molds are stacked and fed from one central sprue. In this case it may be that the blows are caused by insufficient venting. If one of the molds is rammed a trifle hard, the tendency toward blows is aggrevated due to the large body of sand through which the gases must pass.

Q & A

## Melting Is Continuous

QUESTION

For the past two years we have been making bedstead frames from angle iron sections with gray iron corner joints which are made in permanent molds by inserting the two portions of angle iron and pouring in molten metal. For that purpose we need a continuous supply of molten iron throughout the day. Our cupola only operates for three or four hours in the afternoon. We tried melting the iron in a direct, oil-fired furnace without success. If a reducing flame was used, the temperature was too low, and if the air was increased to get a higher temperature, the metal became oxidized. We desire about 200 pounds of molten metal an hour, and would like to know if an electric furnace will serve the purpose.

ANSWER

Apparently, the oil-fired furnace you have been trying to use either is an old type furnace, or it was not designed to give high temperature. At least one firm in this country is using an oil-fired, open-flame furnace for melting iron and steel for valve manufacture.

Undoubtedly an electric furnace also will solve your problem. They are made as low as 250-pound capacity, but we believe that perhaps a 500-pound furnace would be more suitable. However, if you never expect to use more than 200 pounds per hour, the smaller size will be ample as the furnaces usually will melt beyond their rated capacities. With a larger furnace, it would be possible to pour out say one-half of the molten metal, and then charge enough cold material of the proper composition to fill the furnace. The molten metal remaining from the previous charge would assist in absorbing the cold material, and perhaps speed the melting operation. Furnace manufacturers whose names appear in the advertising pages of THE FOUNDRY will be glad to give you information and assistance in solving your problem.

STEEL

## Adopt Pattern System

QUESTION

We shall be pleased to have you advise us of a good pattern storekeeping system. We operate a jobbing steel foundry employing about 250 hands and carry large numbers of customers' patterns in addition to our own.

ANSWER

A pattern storage system is based on simple principles, but the detail of carrying out any system is subject to a multitude of variations due to local conditions. For example in one plant all the patterns may be small and mounted on boards or pattern plates. In another the patterns may vary in size from that of marbles to anvil blocks and each pattern is a separate entity. Manifestly, a pattern storage system that would cover one to perfection, would not cover the second satisfactorily. Therefore, it will be necessary to consider the various types of patterns that you receive, and work out a compromise that will fit your particular case. You probably could gain much information by visiting a number of foundries in your locality.

Essential factors in any pattern storage system include (1) An office file containing a card for each pattern, and with spaces for all necessary data. (2) An index file which may be arranged in any arbitrary manner, but which in this particular instance, may be based on customers' names in alphabetical order. (3) A pattern storage building equipped with shelves and divided into sections suitably marked. (4) A definite series of letters and numbers.

In a general jobbing foundry each customer can be given a definite number for identification and then each of his patterns is marked serially. If necessary his patterns may be divided into groups with an identifying letter and number for each group. As an illustration consider a customer like the Great Western Iron & Steel Co. Inc., which buys castings for a great many departments. The customer is set down as *A*, each department is given a number and then the various patterns required for that department are numbers serially. Thus—for example—an open hearth door sill for the Great Western Iron & Steel Co., Inc., would be marked *A*-3-27. *A* is the company identification mark, 3 is the open hearth group and 27 is one of a series of consecutive numbers applied to patterns for the open hearth department of that particular organization.

After the alphabet is exhausted it can be repeated again as often as necessary by prefixing a number. Thus 1*A*, 1*B*, 1*C* and so on practically indefinitely. Interesting articles on the subject of pattern numbering and storage, appeared in THE FOUNDRY March 15, 1927, Aug. 15, 1927 and Feb. 1, 1928. While none of these deals specifically with a jobbing foundry in which the greater number of patterns are brought in from the outside, still they may suggest or serve as the nucleus of a method of meet your particular requirements.

MALLEABLE

## Theory Is Not Correct

QUESTION

One of our men advances the theory that regardless of the silicon and carbon content in our white iron analysis, the shrink would be about the same, provided the combination of both would not go above or below the limits set for our purpose. As an illustration he states that an iron with 0.65 per cent silicon and 3.00 per cent carbon will not cause any more shrink in heavy castings than an iron with 0.80 per cent silicon and 2.85 per cent carbon. You will note that the sum of silicon and carbon is the same in both instances. Is the theory correct or should the carbon be increased or decreased along with the silicon? If we increase our silicon should we increase or decrease our carbon in proportion to eliminate or decrease shrink in our heavy castings?

ANSWER

There is no substantiation for regarding the sum of silicon and carbon as a criteron of any particular property in malleable cast iron. Thrasher, many years ago worked out the relative effect of the two elements with regard to mottling, and his diagram has been elaborated by Schwartz on page 56, Fig. 27 of his *American Malleable Cast Iron*, where it is shown that the tendency to mottle is measured in the lower carbon ranges by such a sum, but in the higher carbon ranges especially for other than light sections, a unit of silicon is much more active than a unit of carbon.

The theory has been advanced by several persons including Schwartz, *Transactions* of the American Foundrymen's association, 1929, that both silicon and carbon increase the tendency to shrink (porosity) and that silicon is about three times as active as carbon. It also has been recognized that other factors than composition, pouring temperature for instance, are preponderating influences in determining the amount of shrinkage. At the two compositions given it is probable that the lower carbon will mottle more and shrink more than the other insofar as these conditions are determined by chemical composition alone.

# The FOUNDRY Family Photograph Album

**Upper Left**

J. B. GREENSTREET

Olney Foundry Co., Philadelphia

**Upper Right**

J. W. BOLTON

Lunkenheimer Co., Cincinnati

**Lower Left**

F. M. ROBBINS

Ross-Meehan Foundries, Chattanoogn, Tenn.

**Lower Right**

DON A. WEBER

Deister Concentrator Co., Fort Wayne, Ind.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

# REGULATIONS FOR THE INSTALLATION OF

## Pulverized Fuel Systems

1. These regulations are designed for application to new installations and when making alterations or extensions to existing equipment. They are not retroactive.

2. Installation of pulverized fuel systems should be under the supervision of engineers qualified by experience in the design, construction and operation of such equipment.

3. In these regulations the terms "adequately," "effective" and "securely" shall be interpreted as conditions subject to the approval of the inspection department having jurisdiction.

### Types of Systems

4. Pulverized fuel systems are of various types; all involve the hazard incident to the creation and possible liberation of combustible dusts unless properly designed, constructed and operated. In general they may be arranged in three classes as follows:

*Class A Systems:* Indirect or those in which the fuel is intimately mixed with air at the point or points where used and involving storage bins at points of consumption.

*Class B Systems:* Direct or those in which the pulverized fuel is fed to a fan by which it is blown as a combustible mixture through large pipes to furnaces or other points of consumption. In the case of circulating systems of this class, the unused fuel is returned to the initial point to again be blown through the line. In these systems, the pulverizers are located remote from points of consumption.

*Unit Systems:* Those in which the fuel is pulverized at or near the point or points of use and delivered directly from the pulverizer into the furnace by means of fan or blower, which may be an integral part of the apparatus; the air being admitted in the apparatus or in conjunction with the fuel. Systems of this type do not employ bins.

## REGULATIONS FOR ALL CLASSES OF SYSTEMS

### Location

11. (a) The building housing fuel pulverizing equipment shall be constructed of incombustible material.

(b) The process of pulverizing fuel may be accomplished either:

(1) In the room or section of the building where it is burned, or (2) In a room, building or floor separated from the rest of the building by masonry walls and floors and used for no other purpose.

12. (a) Where the process of pulverizing fuel is carried on in the room or section of building where it is burned and the volumetric capacity of the mill housing, mixing or separating chamber (if any) and all of the piping conveying coal suspended in air does not exceed 100 cubic feet, all such piping shall be at least equal to the requirement of Paragraph 25, Specification No. 1.

(b) Where the volumetric capacity of the mill housing, mixing or separating chamber (if any) and all piping conveying fuel in suspension in air exceeds 100 cubic feet all such piping shall be at least equal to the requirements of Paragraph 26, Specification No. 2, and all mixing and separating chambers shall either be constructed for a working pressure of 50 pounds per square inch with a factor of safety of 4 based on the ultimate strength of the material, or located in a separate room or floor cut off from the rest of the building and constructed in accordance with Section 13.

Recommended by the National Board of Fire Underwriters, and adopted as an American Standard by the American Standards association.

(*Continued on Data Sheet No.* 844)



# REGULATIONS FOR THE INSTALLATION OF

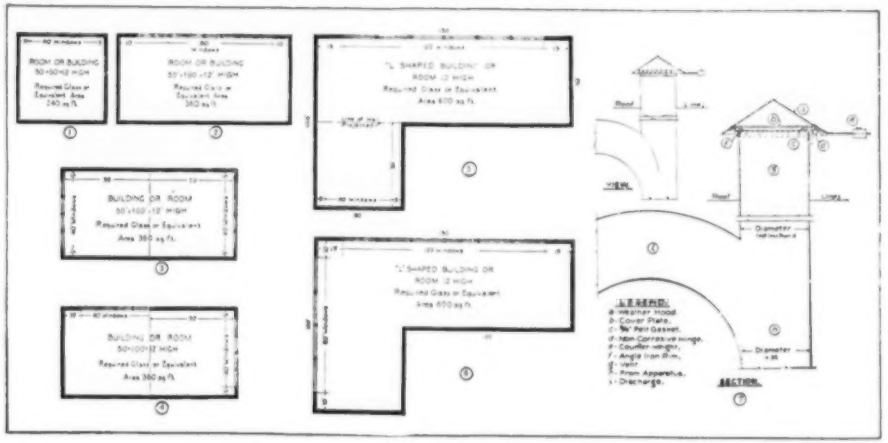
## Pulverized Fuel Systems

(*Continued from Data Sheet No.* 843)

(c) Where an inert atmosphere containing not more than 13 per cent of oxygen is maintained in an approved manner within the mill, separator and piping, the entire milling and separating system, regardless of cubic capacity, may be located within the room or section of building where the fuel is burned. All piping conveying fuel in suspension in gas shall be at least equal to the requirements of Section 25, Specification No. 1, and the separator (if any) shall be constructed in accordance with Section 19.

### Construction

13. Where the process of pulverizing fuel is accomplished in a room, building




*Figs. 1 to 6—Relation of Required Glass or Equivalent Areas to Cubic Content of Pulverizing Rooms. Fig. 7—Suggested Forms of Safety Relief Vent*

or floor separated from the rest of the building by masonry walls, such building or section of building shall be constructed as follows:

(a) It shall be constructed of incombustible material and specially designed (1) to secure minimum lodgment of dust; (2) so that all interior parts of the building on which dust may lodge may be cleaned readily; and (3) to relieve the force of an explosion through skylight, window or explosion doors.

(b) Depending on local conditions either light or heavy type of building construction may be used.

(c) A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the enclosing walls shall be of light non-combustible material, preferably thin glass, so located and arranged that it shall not be a greater distance from the opposite wall or walls than the least horizontal dimension of the room; or where confined to end walls the length of the room shall not exceed twice the least horizontal dimension of the room. The width of the corner jamb or wing wall formed by a wall thus pierced and the adjacent wall shall not exceed

(*Continued on Data Sheet No.* 845)

# Problems in Nonferrous Founding

By Charles Vickers

## Slush Molding Castings

*Can you give me any information on slush molding? I am contemplating the manufacture of animals, etc., so generally used at present for books ends, door stops, desk articles, etc. Such castings require a multipiece mold, but I am at a loss how to proceed to obtain the desired results.*

If you ever have had any experience in making statuary or other work that contained relief that required the use of drawbacks in the undercut surfaces, you will see the similarity of procedure in constructing a die or mold either for die casting or slush molding. The number of separate parts in the mold will depend on the symmetry or lack of symmetry of the desired casting. For example, in one the die may be parted so that only two pieces are necessary, and in another it may require five or six parts.

Since in your case the metal will be a low melting point, white metal, a bronze mold will be suitable for casting. In die casting the molds are tooled from special die-block steel. The first thing you will have to do it to obtain your model or pattern, and lay out the necessary parting lines. After you have laid out the parting lines, put the well-oiled pattern or model in a wooden box that is open top and bottom and which will allow a space of about 2 inches all around the model. This box is placed on a flat plate and forms the container for the plaster of paris which will be used. The model will have to be supported on the bottom by small, stiff wires which will raise it sufficiently to give the necessary space on the under portion.

The parting lines in the box are formed by thin pieces of oiled sheet metal or paper. Sheet metal probably will be better to use as it will retain its stiffness. These sheets or parting lines follow those previously laid out and extend from the sides of the box to the model and are cut to follow the contour at that point. After the parting lines are placed and fastened to prevent shifting, the box is filled with liquid plaster of paris which is allowed to harden.

When the plaster of paris is dry, the sides of the box are removed carefully. Then if you have arranged your parting lines correctly, you should have no difficulty in drawing away the several plaster parts that compose the master mold. If this cannot be done, observe the cause of the difficulty, and make another plaster mold; taking into account the cause of failure to draw. Assuming that you were successful the first time, examine the face of the plaster mold to see that the details of impression are sharp. If they are not satisfactory, careful work with a sharp tool will bring them to perfection. However, see that in performing that operation that you do not undercut the surface for if you do, you will be unable to remove it from the sand in the next operation. Then give the plaster a coat of shellac.

After the mold has been finished to your satisfaction, use the plaster masters as a pattern for a bronze mold. These may be made separately or several in a flask. The plaster master molds should be withdrawn from the sand without any trouble and leave a fine impression if the molding is done carefully. The mold then is filled with molten bronze. After cooling and cleaning, the separate parts are assembled. If all work has been performed carefully, the pieces should fit closely together with only narrow openings between the parts. The gate in the mold is of ample size and usually at a place it will not show in the finished casting. Generally, the mold is arranged so that it is open on top and on a swivel. The metal is poured in, allowed to set for a minute or two and then the mold is turned over which allows the still molten metal in the center to run out.

Q & A

## Makes Colored Brass

***Can you give me any information on how to make green brass castings? Can an alloy be used or is the color obtained by other means?***

An alloy composed of 80 per cent copper and 20 per cent zinc is known to the trade as green brass. The green shade comes within the range of 75 to 80 per cent copper and 20 to 25 per cent zinc, and usually the alloys are used for drawing into fine wire known as fourdrinier wire which is used extensively for weaving the screen cloth used in paper mills. The color is far from a distinct green, being merely a greenish tinge. Brass may be colored by using a dip composed of 1 gallon of water, 2 ounces of sal-ammoniac and 12 ounces of copper sulphate. Have the water boiling and add the salts, being sure that all are dissolved before using the solution. The solution should be used while hot. If you can keep it at the boiling point so much the better. Have your brass cleaned well so that no dirt or grease is present; immerse it in the solution and in a short time the desired color will be obtained.

Probably the best book for your purpose will be *Metals and Their Alloys*, by Charles Vickers. This book covers all manner of nonferrous alloys and includes information on mixing, melting and casting them and data on the physical and chemical properties. The book may be obtained from The Foundry.

Q & A

## Sand Must Be Open

*We have a number of bearings weighing 625 pounds each to make. Our sand is stoveplate grade, and we know it is too fine and close. We wonder whether mixing in seacoal facing would help matters. The mixture to be used for the bearings contains 82 pounds of copper; 8 pounds of tin; 5 pounds of lead, and 5 pounds of zinc. Half of this is to be new metal and half scrap of the 88-10-2 composition containing 2 per cent zinc. In what position should the bearing be molded? How should we gate and riser it, and at what temperature should the metal be poured?*

We are doubtful about the value of seacoal when mixed with sand as fine as you have. It is entirely too fine for casting 600-pound pieces. More than half of the troubles of the brass founder come from using molding sands unsuited for the type of work he is called upon to make. Theoretically a casting that size should be molded in a No. 3 grade Albany sand and made in green sand.

You should make a study of sands to determine the best for your purpose, but in cases where you are called upon to make an occasional large casting, open your sand by adding sharp sand. One formula that has been used with satisfaction contains 10 parts of new molding sand; 5 parts of sharp

sand, and 1 part of finely ground fireclay. Mix well and dampen with water. If the mold is to be dried add 1 part flour to 20 sand, and molasses water to dampen. Swab the mold face with plumbago and dry.

The bearing should be molded half in the drag and vented well with a fine wire. If there is a flange at one end, tilt the pattern slightly to obtain a good lift for the cope. Otherwise mold level. The sprue and riser may be placed on the same end or on opposite ends. If on opposite ends, tilt the flask for pouring so that the riser is higher than the sprue. Gates are cut to both sides of the casting and the sprue is located in the center of the end of the bearing. When the sprue is filled, cover with sand and place a weight on it. Then fill up the riser which has been bushed 6 inches higher than the top of the cope section of the mold.

# Readers Comment

**Note—Material appearing under this head does not necessarily reflect the opinion of The Foundry or of its editors.**

To the Editors:

In the Nov. 15 issue of The Foundry, an inquiry was published on what caused brass castings to turn white. Apparently his trouble results from contamination by aluminum. A piece of aluminum as large as a 25-cent piece in 250 pounds of brass will cause a white coat on all the castings poured from that metal.

Charles Klotz

*New York, N. Y.*

## Technical Men Needed

To the Editors:

I agree with E. O. Keator, whose article appeared in the Oct. 1 issue, that foundrymen should have well trained technical men in their organizations. When Prof. Beese questioned the advisability of teaching foundry practice to engineering students, the foundry industry was beginning to realize that the older men with a vast supply of practical foundry knowledge fast were dying out. His letter brought the idea forcibly to its attention.

When castings were made by hand methods, skilled molders were developed who had sufficient knowledge to plan the procedure on a certain job. In the most advanced foundries of today, molds are made on molding machines on which patterns are mounted. Little molding skill is necessary to operate a molding machine and the work generally is done by a handy-man and not a molder. Molding machine operators do not need to know how to plan the work and therefore never learn.

Under present conditions, sand is prepared for the molding machine operator. He knows nothing about the best kind of sand for a certain mold or the proper condition it should be in when it is used. The knowledge of how molds are made, the proper kind of sand to use, and many other factors in foundry work must be retained and advanced if the foundry industry expects to maintain its markets against other divisions of manufacture that are training men to give them the best information possible.

The use of machinery in making castings makes the planning of procedure more complicated than it was when hand molding was in vogue. Many foundries have not kept up with development as it shown by the number of foundries in which molding machines are idle because no person in the shop knows how to prepare patterns for the apparatus. If the foundryman is asked why the machines are not in use, the reply will be "We do not get good results from their use." In the same shop, molders often will be making castings which could be made three times as fast on the machine and would have a much better appearance and would be truer to size.

Since men are not being developed to plan the production of castings under present conditions, it is necessary for foundrymen to train a group of men in each shop who can decide the best methods to be used in making castings. Those men also should have a technical education so that they can apply the laws of physics, chemistry and engineering to the work. Technically trained men will be able to put a foundry on a paying basis providing they have been trained in the foundry after their college course has been completed. Employing a college graduate and expecting him to put a shop on a scientific basis without a thorough training in foundry principles will not solve the problem.

Colleges can teach the fundamentals of physics, chemistry, engineering metallurgy and principles of foundry practice, providing the institution maintains a foundry laboratory, but the graduate will need a thorough drill in the application of those principles before he will be a mature technician, capable of solving foundry problems in a satisfactory way.

Foundrymen are beginning to realize the necessity of securing technical aid. That is shown by the action taken at the A.F.A. convention at Cleveland when the society voted to appoint a committee to work with the colleges in developing a course in foundry practice to be taught to engineering students. That action is in the right direction and will help to place the foundry industry on a more scientific basis.

R. P. Hall

*Assistant Professor of Industrial Engineering,*
*Pennsylvania State College,*
*State College, Pa.*

## Molding Is Important

To The Editors:

In the Oct. 15 issue of The Foundry the writer came across an article in the section devoted to foundry problems entitled "Vises Show Defects" with which he does not agree. It is stated that the character of the sand, the iron and shaking out are not factors. A good grade of iron is necessary if a vise is to stand up as it receives considerable abuse. Sand used for ordinary castings will not be satisfactory as the iron has to be poured extremely hot especially in the case of vises with steel-faced jaws. The vise castings have to be poured hard and if the sand is not of the proper grade and rammed correctly, it will wash; leaving plenty of dirt holes.

Since the iron is poured as hot as possible and the jaw face is made of tool steel, a vise should not be shaken out too soon as red hot tool steel exposed to the air becomes to hard to machine. It also is stated in the article that steel face plate is responsible for all or nearly all the castings that are rejected.

The writer believes that if the gates are made properly no difficulty will be encountered in fusing the plate to the jaw. A thin knife gate should be used and the metal poured hard. Ramming the mold is important due to the shape and section of the jaws. The front jaw has a heavy solid section on the front and a thin section on the beam. If rammed too hard on the heavy section, shrinkage will occur on that section, yet the mold should be rammed hard around the gates.

M. K. Selers

## Adds Three Members

The following companies recently have become affiliated with the Gray Iron institute: Howard Iron Works, 287 Chicago street, Buffalo; Erie Foundry Co., 50 Dewey avenue, Rochester, N. Y.; and Lake Erie Engineering Corp., 268 Perry street, Buffalo.

Snyder Foundry Supply Co., Los Angeles, recently has added a roofing department to its business.

# BECAUSE *It's Tested, Millions* Travel SAFELY

By H. F. Moore

ORDINARILY we think of the days of prophets and soothsayers as past, but this is not so. True, styles in prophets have changed greatly since the days of the Witch of Endor and the Delphic Oracle. Prophets of olden time, in performing their official duties, mumbled incantations, brewed magic messes, and made wise cracks about the arrangement and the significance of the intestines of freshly slain fowls. Prophets of today make predictions with the aid of the test tube, the microscope, the slide rule, and the testing machine.

A large group of modern prophets make a business of predicting how steel, brass, aluminum, concrete, brick, wood, and rubber may be made to serve satisfactorily as materials for buildings, locomotives, automobiles, airplanes, sewers and bridges. As in the ancient world there were schools and fraternities of prophets, so in the modern world the prophets gather together into associations and societies, and the American prophets of the strength and durability of materials are gathered into the American Society for Testing Materials.

### Many Materials Available

In *The Outline of History*, H. G. Wells recognizes one fact which most of the older historians have failed to see, namely that one important element in our modern civilized life is the fact that today we have available many *materials* whose strength can be predicted and controlled. Builders of the ancient world had to take materials as they found them in nature. Even the makers of the famous Damascus and Toledo blades were largely dependent on the occurrence in nature of fortunate combinations of ingredients in the ores near at hand. They used many a weird rule of thumb in tempering their steel, and kept no record of their failures.

When we think of the marvels of modern applied science we naturally think of dramatic marvels, the giant locomotive, the light but powerful airplane engine, the 125,000-horsepower dynamo, the sky scraper; but not one of these would have been possible unless there had been developed strong, durable, workable materials out of which to build them. We all cross bridges, walk under trolley wires, ride in automobiles, and our personal safety is dependent a score of times a day on the strength of the material.

Not only are we all vitally concerned with our physical safety, we are also greatly concerned with the *cost* of living, the cost of clothing, household goods, farm implements, with the amount of the taxes we must pay to keep up sewer systems, pavements, water works. Now a large factor in determining these costs is the wisdom used in selecting suitable materials, materials whose money cost, strength, and durability are well balanced.

## Romance

*THE prophet speaks! Not the soothsayer of the past, but the modern prophet who makes use of twentieth century knowledge to determine the strength of materials used in the products of industry which have become common today. On Nov. 1, through the medium of the radio, fireside gatherings throughout the country were told of the romance of engineering materials by one of the leaders of this school of modern prophets. The speaker at this interesting broadcast was H. F. Moore, research professor of engineering materials, University of Illinois, Urbana, Ill., and past president of the American Society for Testing Materials, sponsors of the broadcast.*

What kinds of tests do these modern prophets of structural stability use in their ritual of prediction? Many kinds. Watch the operation of a big concrete mixer on a job of road building. Every once in a while a young chap comes along, takes a bucket or two of concrete from the sticky stream pouring out from the mixer, and pours this sample of concrete into molds in which the concrete hardens into cylinders about the size and shape of a large baking powder tin. Then after, perhaps, a week these hardened cylinders are tested to destruction, that is squeezed to bits in a huge press which is fitted with heavy platform scales to weigh the pressure applied. If the sample cylinders do not withstand a sufficiently high pressure the concrete job is condemned, and it must be torn up.

Sometimes material can be tested without destroying a sample of it. If you get a chance to examine the crankshaft of an automobile engine you will find somewhere on it what looks like a little dimple. That dimple is the test mark resulting from pressing a ⅜-inch steel ball against the shaft with a pressure of 6600 pounds. The harder and stronger the steel, the smaller the dimple. If in the factory a shaft comes to the inspector in which the test dimple is too large, that shaft goes back to be tempered over again.

### Chemist Aids Quality

Of course, the chemist with his test tubes and balances and ability to tell what ingredients are present in any material, and how much of each, is one of the fraternity of materials prophets. If the chemist did not inform the rail mill when there is too much phosphorus in the steel they are rolling we would have many more railway accidents than we do, and if the chemist did not keep the rubber manufacturer posted on how much sulphur there is in the rubber we would have much more tire trouble on our week end trips.

Prophets who use the microscope show just how metals are made up of little crystalline grains, and the newest of the schools of materials testers make the X-ray show up hidden flaws in the inside of material. They also show the pattern arrangement of the very molecules in a solid, particles so small that it takes about 300 of them end to end to be visible to the most powerful microscope.

The development of the science of testing materials is a comparatively recent thing. Perhaps the first systematic testing of materials was done some two and a half centuries ago in connection with insuring a standard quality of coinage. That gigantic figure in the scientific world, Sir Isaac Newton, did not think it beneath his dignity to spend many of the best years of his life developing standards for metals and processes in the British mint. However, the idea of systematically testing the common materials of every-day use is quite recent. The troubles of the early

railroads with axles and rails was a great factor in encouraging such testing. The Prussian state railways back about 1850, and our own railways in "the gay 90's" began to demand materials whose strength and ductility were not merely glibly promised by the maker or by his salesman but were shown to exist by actual tests.

Speaking of buying materials on the reputation of the maker without further testing, I remember in my boyhood days the quality of steel in our jack knife blades was judged by the reputation of the maker's name. Back in New Hampshire the boy whose knife blade bore the name Jonathan Crooks was sure he had a superior article. Actually it was not at all difficult to stamp the name Jonathan Crooks on an inferior blade, and blades so stamped were sold.

Fifty years ago there were few standard tests or specifications for any of the ordinary materials in use; today there are some 10,000 well recognized standards for materials. We may decry over standardization, but certainly we should have to do without many modern conveniences if standardized, predictable, materials ceased to be produced.

### Tests Show Quality

It is obvious that before any test, whether of strength, wear or color, can be accepted as a standard test for a material it must be shown that the test really shows the presence or the absence of the desired service qualities in the material. Some spectacular tests really tell little about these qualities. There used to be a superstition that if an elephant would set foot on a bridge the bridge was safe. The huge animal was credited with a mysterious and infallible sense of safety. As a matter of fact the slow steady tread of an elephant would not be nearly so likely to cause the bridge to fail as would the banging of a heavy motor truck, and no one ascribes any infallible sense of safety to either the truck or its driver.

But tests which are made with scientific apparatus and which seem scientific may be as lacking in reliability as the elephant test. For example, the resistance of a metal to corrosion is sometimes prophesied from the results of a test in which it is dipped in strong acid for a few moments. The amount of metal dissolved in the acid is taken as a measure of its corrodibility. As a matter of fact a low loss of weight in this test is no proof whatever that the metal will resist ordinary rusting in air and smoke and rain.

Sometimes material is tested by being subjected to two or three times the load it will have to stand in service and if it withstands this test load without fracture it is judged fit for use. This sort of overload testing is rather dangerous. It cannot be safely assumed that because a heavy overload is safely carried once an ordinary load can be carried thousands or millions of times. That one heavy overload may have started tiny cracks in the material and under thousands of repetitions those cracks may spread, like the crack in a glass show case until a shaft or a beam suddenly snaps in two without warning. Most of the failures of materials in airplanes and high speed machinery are of this class. Fatigue of metals is the name given to the destructive action of these cracks.

### Material Should Be Tested

Railway inspectors remove axles from locomotives and from elevated and subway cars after a certain distance has been run and examine them minutely for evidences of the beginnings of such cracks, and if the smallest crack is detected the axle goes to the scrap heap.

Before putting much confidence in the statement that a material has been tested it is well to find out whether it has been tested by *standard methods*, methods recognized by some of the scientific bureaus of the government or by some technical society. It has come to be recognized that in devising tests and standards for materials it is vitally important that the interests of both manufacturer and consumer be considered. If the consumer alone is allowed to write specifications for a material he is likely to set up a number of fussy requirements which do not add much to the reliability of the material, but which do add greatly to the cost. On the other hand, if the manufacturer alone is allowed to write specifications he will almost certainly see to it that the materials shall be easy and profitable to produce. These statements are no reflection on the morals of either consumer or producer: they simply recognize the fact that every man naturally over emphasizes his own viewpoint.

In the American Society for Testing Materials the standards for materials and methods of test are prepared by some 50 committees, committees for steel and iron, for other metals, for concrete, brick, textiles, timber, rubber, etc. Rules of the society require that on each committee there must be representatives *both* of the manufacturer and the consumer. Rarely does the society accept the recommendations for a new standard unless there has been practical unanimity between manufacturers and consumers. That is, a proposed test or specification does not get recognition until a representative group of manufacturers and consumers has talked it over and decided that it is reasonable, safe and useful.

Most of the actual testing of materials is not at all romantic to watch. However the test of a material for strength is an interesting sight to watch. A piece of steel, aluminum, or copper is fastened in a powerful machine and is pulled. It stretches, necks down like a piece of molasses candy, and finally breaks in two with a loud bang. A block of concrete is compressed and finally splits into fragments. A timber beam is bent into a flat bow and finally cracks.

However, to the materials testing prophet the romance of his work lies mainly in what that work means to the millions of men and women who are daily users of materials. He visualizes the aviator successfully handling his plane in the air, trusting confidently that the tested material in his wings, his engine, and his propellor will withstand the severe strains of flying; and in spite of the newness of the art of building airplanes this confidence is rarely misplaced. The materials tester visualizes men and women everywhere protected to an almost unbelievable extent against accidents in the home, on the street, in cars and automobiles by the use of safe, tested materials. He visualizes the farmer, the housewife, the tax payer given full value for the millions of dollars expended for the materials used in building roads, sewers, water pipes, buildings, clothes, railway cars, autos and airplanes. He rejoices that he has a part in increasing the safety and comfort and lessening the dangers of our modern mechanized life, and that he is giving folks more leisure and less anxiety so that they will have more energy available for developing the beautiful and the good in their lives, —if they will only do so.

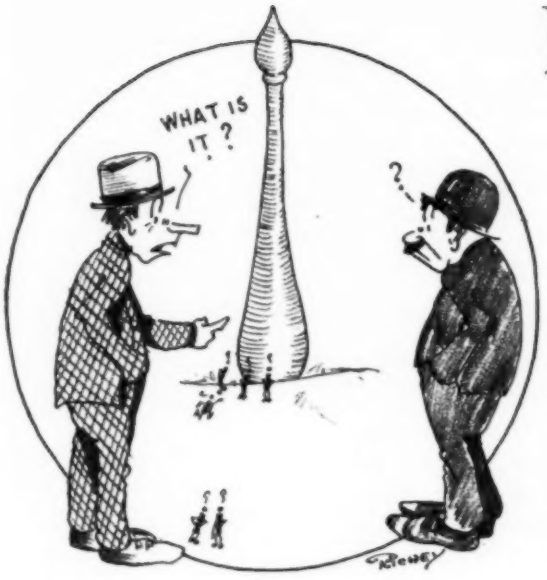
## Committee Summarizes Fatigue Views

The research committee on fatigue of metals of the American Society for Testing Materials recently published a 52-page bulletin summarizing present-day views regarding fatigue phenomena in metals. The bulletin is divided into sections covering the various phases of fatigue phenomena and testing. Authors of the sections include R. R. Moore, Wright Aeronautical Corp., Paterson, N. J.; J. R. Townsend, Bell Telephone Laboratories Inc., New York; J. B. Kommers, University of Wisconsin, Madison, Wis.; H. S. Rawdon, bureau of standards, Washington; H. F. Moore, University of Illinois, Urbana, Ill.; R. L. Templin, Aluminum Co. of America, New Kensington, Pa.; H. W. Gillett, Battelle Memorial institute, Columbus, O.; T. McL. Jasper, A. O. Smith Corp., Milwaukee; and R. E. Peterson, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

John A. Wahlgren has been appointed general sales manager, New York Belting & Packing Co., 91-93 Chambers street, New York. He has been associated with the rubber business for the past 12 years.

# Bill Presents Theory on Pillar of Delhi

## By Pat Dwyer




"SAY," said Bill the other night, "you are all the while prowling through books of one kind and another. Perhaps you can tell me something I should like to know."

"If this information is in a book," I pointed out quite logically, "why don't you hunt it up for yourself, instead of bothering me?"

"Well," Bill replied, "for one thing I should not know where to look. Anyhow, why should I spend hours and hours searching for information which you probably have at the tips of your fingers, or to be more accurate, at the end of your long tongue."

"There may be something in that objection," I admitted, graciously. "You may fire when ready, Gridley."

"Where does this Gridley guy come in?"

"Merely a figure of speech, dear lad. Merely a figure of speech to indicate that I am in a receptive mood. I shall be glad to hear your question, but something seems to tell me I do not know the answer. However, never shall it be said that I turned a deaf ear to the cry of distress, or threw a cobblestone at the seeker after bread. Your servant, Sir!" "Your servant, me eye!" Bill remarked rudely. "Where do you get this bread and cobblestone stuff? I want to ask you about this famous iron pillar of Delhi in India." "What do you care about the pillar of Delhi? It is not a casting. It is a wrought iron job and therefore of no interest either to you or to me. Now if you want to know about—" "Listen," Bill interrupted, "Who is asking this question you or me? Personally, I don't care whether the thing is wrought iron, cast iron, chalk or cheese, but a fella wrote to me recently to ask if I knew how it was made." "Do you know?" "No, but—" "Well, then," I said, "write to him and tell him you do not know anything about it. Just say: 'Dear Sir: In re your recent inquiry on the pillar of Delhi, beg to advise I know nothing.'" "Know nothing?" Bill repeated suspiciously. "A dirty crack, I calls it. I was kind of banking on getting some information out of you, but if you know nothing—"

"Heave the lead," I interrupted, hastily. "She is getting into shoal water. How did this thing start?"

"Well," said Bill, "I'll tell you. A friend of mine in Buffalo saw a picture and a brief description of the pillar in *Believe-it-or-not*—Ripley's corner of a newspaper page. He sent the clipping to me accompanied by a brief note: 'Please tell us who made this iron pillar, and how.'"

"'And how', is good," I commented. "Carry on."

"Oh I don't think he meant it in that sense," Bill said. "I think the inquiry was in good faith. He wants to know how the thing was made. If you can throw any light on the subject, now is the time to polish up the lens in the old bull's-eye lantern. Kindly direct the rays this way. I have a theory on the subject myself, but I am open minded and am willing to compromise if necessary. Nothing could be any fairer than that, hey?"

"At various times," I said, "I have read accounts of this marvelous pillar, but up to the present I never have seen a first hand account, written by a man competent to describe it as I should like to see it described. In every instance the account has been second hand, a series of quotations from something some one else wrote.

"These stories go into considerable detail on the history of the pillar, its significance, the inscriptions with which it is decorated, the shape and size, the composition and other details, but every one shies away from any reference to the most important feature. Possibly none of these writers was interested in this prosaic phase of the subject. The average engineering student emerges from college with the same attitude toward the manufacture of castings. He has a vague idea that a casting is formed by digging a hole in some clay and pouring metal into it. A kind of a messy business carried on by grimy workmen in ragged clothing, but of no particular importance. He has not the slightest conception of the skill and knowledge required—"

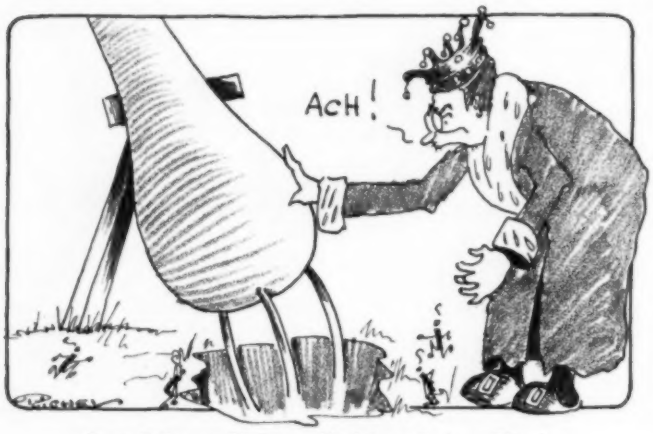
"Spare the lecture," Bill said, "I have been through the mill. Stick to the pillar. What else do you know about it?"

"In one account," I said, "presented before a learned society some years ago, the author quoted from various writers to the extent of 2000 words. The only reference to how the pillar was made was contained in one sentence. One single solitary sentence to the effect that the pillar was made from pure iron and was formed by welding a number of blooms. In another account of almost equal length, also made up principally of quotations from previous writers, the author ventures the opinion that the pillar was fabricated by welding together a succession of disks. You pays your money and you takes your choice." "The whole thing," Bill remarked, "sounds kind of fishy to me. A solid column 30 or 40 feet high and 2 feet in diameter, made up of a number of

*Old Proverb: A Club in the Bag Is Better Than Two on the Bean*

disks is some welding job. You will be telling me next that they employed an arc welding outfit with current derived from a municipal power station."

"That solution had not occurred to me," I admitted. "Singularly enough no other person, so far as I know, ever thought of it either. The fact that the electric welding process is a comparatively recent development, possibly may be responsible for the oversight.




*Just Like a Molder Shaking Out a Waster*

"I am not prepared to discuss that point, but my information on the dimensions of the pillar does not coincide with your statement that the shaft is 2 feet in diameter and 30 or 40 feet high. According to my authorities the pillar has a total length of 23 feet 8 inches, of which 22 feet, 6 inches is above the ground and the remainder below. The bottom diameter is 16½ inches and this tapers away to 12½ inches at the top where the column is surmounted by a capital 3½ feet high.

"Also, in case you still are interested, the bottom of the pillar, the part under the ground, swells out like an onion, or a turnip. To further carry out the comparison this bulb is ornamented with eight small straight bars which enter the masonry foundation where they are anchored with lead."

"I can see it coming now," Bill said.

"See what coming?"

"The legend connected with the pillar. You are going to tell me that away back in the reign of Rhamadam Dishpan, the champion fakir of the period put on a little exhibition in the palace yard one morning. He drew black birds out of his whiskers and caused an orange tree to rise out of the barren ground and bear fruit while the spectators gazed goggle eyed. He placed his helper in a basket, plunged a long sword through it several times and withdrew the sword, dripping with blood. Then opened the basket and the unharmed boy stepped forth.

"For a finishing touch he planted a 6-inch spike in the ground and—believe it or not—in 5 minutes by any reliable stop watch, the pillar sprouted out of the ground and assumed the shape it bears to this day, a wonderful example of endurance.

"The fakir shinned up to the top as nimbly as any modern line man. He poised on one big toe long enough to bow his acknowledgment to the applauding populace. Then he threw a long rope up in the air, climbed to the top hand over hand, pulled the rope up after him and disappeared, and never has been seen from that day to this. How's that, my lad, for a bit of the old mind reading?" "Not bad," I admitted. "Not bad for an amateur with a memory for some of the Hindu magic stories that appeared in the old *Boys Own Paper* in the nineties. I wonder if it still is published. I have not seen a copy since I left my father's house, flew away from the happy little home nest to seek by fortune—save the mark—over 30 years ago.

"However, you are slightly in error in your great mind reading act. Probably tuned in on the wrong wave length. The legend connected with the pillar is remarkable in many respects. It is a credit to the imagination of the ingenious lad who invented it, but a sad commentary on the credulity of the millions who accepted it as gospel since about the year 400 A. D." "Spare your sympathy," Bill remarked, "and apply it nearer home. We still lap up the old baloney and cry for more. Millions of people in this enlightened twentieth century believe that Columbus was the first white man to set foot in America, that Noah had two of each species of animal, bird, fish and reptile in a scow 30 x 120 feet, that colleges maintain football teams to give their young men exercise, that the government is responsible for the present industrial depression, that the touch of a toad will produce warts on the hands and that fortune tellers can disclose the present, the past and the future. Only last year a man was accused in Pennsylvania for casting spells on another. Before casting aspersions on any people for their curious belief, you should look around, kid, and step warily."

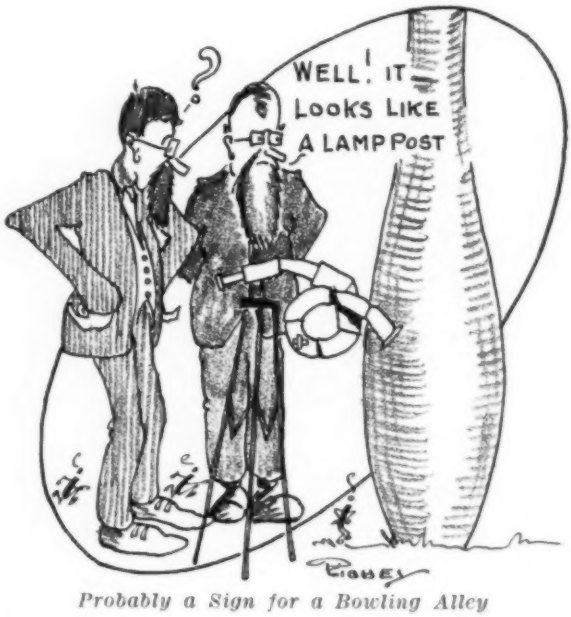
"Objection of my learned friend sustained," I admitted handsomely. "Consider former comment expunged from the record. Naturally enough that brings us back to the legend connected with the pillar. I wonder if you ever reflected on how far back the history of India extends. Apparently the country was fairly well populated and enjoying a species of civilization at a period when the inhabitants of Europe were living in caves—one cave per 67.736 square miles—were using bone implements for offense and defense and knew no more of fire than they did of pots and pans."

"Wait a minute," said Bill. "How do you know the caves were arranged one per so many square miles and so many decimal parts thereof?"

"That was the first combination that came to mind," I said. "At this late day it will serve as well as any other. The number really is immaterial. I merely wished to convey the general impression that the inhabitants of Europe were not crowded for room and were not organized into groups either local or national. They had nothing worth taking away and consequently no outsiders bothered them and they did not trouble each other. No country has a ghost of a chance of breaking into history until it starts fighting."

"Since you are so handy at guessing," Bill said, "and quoting figures, when did the history of India begin?"

"You might just as well ask me when the world began to whirl on its axis. I don't know. Historians seem to be agreed on the fact that the Aryan invasion occurred about 1000 B. C. The Persians under Darius stamped around the country with hostile intent in 518 B. C., and their example was emulated by Alexander the Great and his Grecian warriors in —lemme see—the year 327 B. C.




*Probably a Sign for a Bowling Alley*

"Outside a few private wars among the tribes, the country skated along peacefully until about 1000 A. D. when a Mohammedan horde over-ran the place like a flock of locusts. Then about 100 years later, that fighting man Genghis Khan and his myrmidons came pouring over the mountains and grabbed everything in sight.

"A couple of hundred years later, back on the old homestead, a descendant of old Genghis on the mother's side, a ruffling young bravo named Tamerlane decided to emulate his ancestor's example. Eastward! Ho! says brave young Tamerlane. Over the hills and far away! Let's go! He collected an immense army and with lance and spear and flying standard, with rolling drums, screaming stallions and shouting men in a cloud of dust he descended into India and set up an empire that endured until the 17th century."

"All very interesting," Bill observed, "but what has all that to do with the Delhi pillar?"

"Delhi was the capital city during all that period and the legend of the pillar is mixed up with the history of the city. In fact it is claimed by one authority that the word *delhi* means unstable and was taken from the condition of the pillar. Another eminent authority politely pooh-poohs this claim and says delhi means nothing of the kind or words to that effect. The study of words, particularly ancient words, is a fascinating occupation—"

"Who cares about the meaning of ancient words?" Bill inquired impatiently. "Language, every language, is in a constant state of flux and the meaning of a certain word may change in a single generation. Naming no names, may I direct your attention to the word dumb? A few years ago the term described a person who lacked the gift of speech. Certainly it could not be applied to you. In its present application it means a person of exceedingly low mentality, even though he may be as voluble as a magpie."

"If a certain magpie would keep his comments to himself," I said, "we might get along faster.

"According to the original legend —of course a palpable exaggeration— the pillar was sunk into the ground until the lower point pierced the head of Vasuki, the old boss serpent who supported the earth. The chief priest assured the ruler—I forget his name—that so long as the pillar remained anchored in that position, his dynasty would endure.

"The high nabob professed to believe, but like the amateur gardener who digs up the seed to see if it has taken root, he had the pillar pulled up one day for examination. The priest was vindicated. The bottom of the pillar was smeared with blood from the head of the serpent. It was all wet. The ruler also was all wet when he attempted to replace the pillar. The wily old serpent, Vasuki, was not caught napping twice. Despite the most earnest effort, the pillar sinkers never could locate the serpent's head and as a result the pillar could not be anchored solidly.

"The ruler lost his life and his throne. Strangers sat in the high places and ran the country to suit themselves. Mighty fighting men of alien race and alien tongue came over the mountain ranges to the north and the west and ruled in India until the seventeenth century. Then the English came from beyond the wild salt seas and gradually assumed control.

"Frequent exhibition—and use—of the mailed fist were involved in the process. According to recent reports the ashes of revolt still are smoldering with a gent by the name of Mr. Ghandi manipulating the bellows.

"Ostensibly the revolt is based on a protest to a taxation on salt, just as the American revolt was based on a protest against taxation on tea, but it also is based to a certain extent on a belief in the old legend of the pillar. The Hindus believe that so long as the pillar stands, they have a chance to regain their supremacy.

"They ascribe all their misfortune to the digging up episode and to the fact that the pillar never has been properly anchored. So long as it is not knocked flat, they figure that eventually they will stage a comeback. Then the fur will fly!"

"If I had charge of the job," Bill said, "I'd soon tie a can to that legend."

"Yeah? You and who else?"

"One helper and a cutting torch would do the trick. Cut away the anchor bolts, stick a long lever under the base of the pillar at one side and over she'd go, bang! Like humpty-dumpty. Then I'd cut the thing in short lengths and have 'em shipped to the Tata Iron & Steel Co., to be thrown into one of the open-hearth furnaces.

"Incidentally I should satisfy my curiosity on whether the pillar is solid as claimed, or a hollow shell, as I suspect. Up to the present I have seen no proof that the shaft is solid and in the absence of proof, one guess is as good as another.

"My own private opinion—and I am sure you are welcome to it—is that the pillar was built up in a succession of rings or short cylinders, say one inch thick and 10 or 12 inches high. Each ring represented a heat from the primitive little reduction furnace, about 100 pounds. Iron was not melted in those days. The iron ore was packed in a furnace with a quantity of charcoal. The charcoal was ignited and a temperature developed sufficient to remove the oxygen from the ore and leave the metallic iron mixed with slag. After the furnace cooled, it was knocked apart and the mass of iron removed. This iron with only a trace of carbon was extremely ductile and easily was hammered to any desired shape and easily could be welded. In this instance the bloom was hammered first to a plate and then bent into a ring. By heating the rims of two rings they could be readily welded to each other. In this manner the pillar could be built up ring by ring to the desired height."

"If your theory is correct," I said, "you will not have to cut the thing apart. You can ship it over here, cut the top off it and sell it to some prominent hotel man for a glorified cuspidor or umbrella stand."

## Coal and Coke Analyses Are Improved

American Standards association, 29 West Thirty-ninth street, New York, has approved the standard methods of analysis and sampling of coal and coke of the American Society of Testing Materials, sponsor of the project. The methods originally were prepared by joint committees of the American Society of Testing Materials, American Chemical society and the American Foundrymen's association. They were adopted by the A. S. T. M. in 1916 and 1918 and were revised in 1921, 1924, 1927, 1929 and 1930 by the committee on coal and coke of the A. S. T. M.

Recent revisions of the methods consist of minor importance and do not change radically any procedures. Changes are the results of investigations of the methods of analysis with a view to increasing their accuracy.

## Standards Association Elects Officers

Bancroft Gherardi, American Telephone & Telegraph Co., New York, was elected president of the American Standards association, to succeed W. J. Serrill at the annual meeting of the association which was held at the Hotel Astor, New York, on Dec. 11. Cloyd M. Chapman, New York, was re-elected vice president. The board of directors includes Quincy Bent, Bethlehem Steel Co., Bethlehem, Pa.; G. K. Burgess, bureau of standards, Washington; Cloyd M. Chapman; C. L. Collens, Reliance Electric & Engineering Co., Cleveland; Howard Coonley, Walworth Co., Boston; L. A. Downs, Illinois Central Railroad, Chicago; F. E. Moskovics, Improved Products Corp.; W. J. Serrill, United Gas Improvement Co., Philadelphia; M. S. Sloan, New York Edison Co., New York, and R. J. Sullivan, Travelers Insurance Co., Boston.

In the report covering the work of the association during the past

year, Mr. Serrill stated that 46 new national standards have been adopted in mechanical, civil, chemical, and electrical engineering, and in mining, woodworking and many other industries.

These include a number of safety codes. New member-bodies that have affiliated with the association include the Institute of Radio Engineers, Aluminum Co. of America, Manufacturers Standardization Society of the Valves and Fittings Industry, National Coal association, and Radio Manufacturers association. Mr. Serrill also mentioned that the American Standards association has been selected for representation on the Council of the International Standards association, which maintains headquarters and holds meetings in Basle, Switzerland.

# Prepares Intricate Bearing Pattern

By P. D. Forbes

The writer recently completed a set of bearing patterns ranging in size from 1 to 12 inches patented by J. D. Jones, Portland, Ore. The feature is white metal liner 5/16-inch thick attached to the main casting and provided with a series of small openings through which the rotation of the shaft pumps oil from the oil chamber. An examination of the illustrations will show that some nice work was required on the pattern and coreboxes.

Both halves of the complete pattern are shown in Fig. 3. The main corebox for the bottom half with its four loose prints to connect the oil chamber core is shown in Fig. 2. The oil chamber core was made in a separate corebox as shown in Fig. 4.

Fig. 4 also shows the main corebox for top half of the bearing with the water space corebox complete in its turn-over frame resting on top of it. The four prints used to locate the water space core of the lower half, the sweep for the top half water space core and a small corebox to form a connection between the oil core spaces in the bottom, also are shown in this illustration. The water space corebox of the bottom half is not shown in any of the illustrations. It is a simple rectangular core with two 1-inch prints for vent purposes.

The patterns differed slightly from

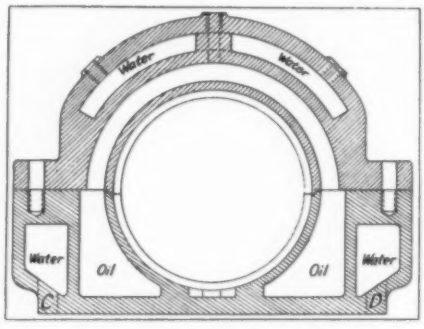



*Fig. 1—Cross Section of Assembled Bearing and Cap*

the lines laid down by the draftsman. In the cover or top half of the bearing the 1-inch outlet core prints were attached vertically instead of on a slant, as may be noted in Fig. 3. Ample clearance was provided on these prints to anticipate any slight shift in the position of the core. The same condition prevailed in the water space core in the bottom half. Two 1-inch outlets may be noted at *C* and *D* Fig. 1. The four loose prints for these cores are shown in Fig. 4. The spaces *A* and *B* Fig. 1. the bottom half of the bearing are cored out, but the corebox is not shown. The projecting prints may be seen in Fig. 3. The corebox is similar to the oil space corebox.

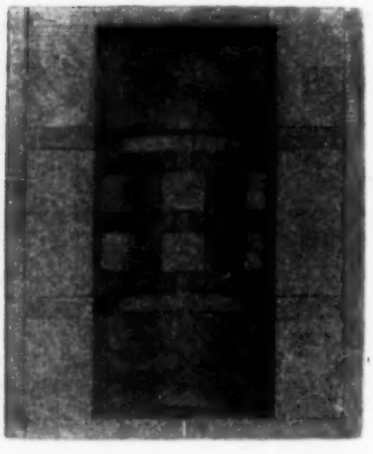
In some of the bearings the water space was placed above the oil space. The oil was pumped through a ½-inch hole in a hub provided for the purpose.

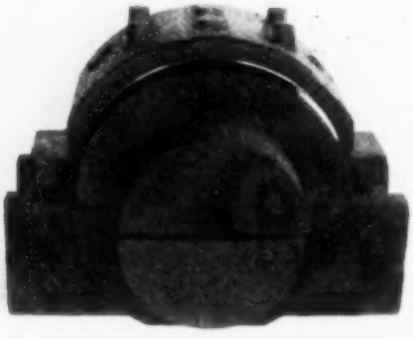
## G. E. Establishes Fund for Unemployed

General Electric Co., Schenectady, N. Y., has established a fund for the relief of the unemployed members of the company organization. Every employe of the company will contribute 1 per cent of his December wage to the unemployment fund and the company will match such contributions dollar for dollar.

The fund was started earlier than was announced in the original plan because of the present emergency. Relief has been started but payments to needy employes has been limited to $15 per week. A plan also is being considered to give assistance to employes who have not contributed to the fund.

Valentine C. Smith, formerly vice president and general manager, Kelly Graphite Mills, Stockertown, Pa., now is associate general manager in charge of manufacture, Bloomsbury Graphite Co., Bloomsbury, N. J.





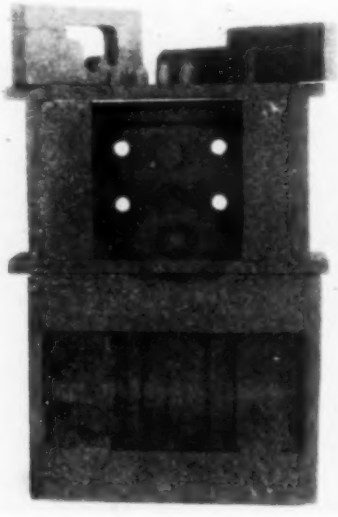


*Fig. 2—(Left)—Main Corebox for Lower Half. Fig. 3—(Center)—The Completed Pattern. Fig. 4—(Right)—The Set of Coreboxes with the Exception of That for the Water Space*

# COMPLETES Nearly HALF CENTURY In the Foundry

ONLY within the past year has J. J. Bever, for 30 years foundry manager for the Otis Steel Co., Cleveland, found time to iron out some of the irregularities and lower the more prominent peaks in his golf score. This highly desirable condition has been brought about through his decision to quit the foundry and go out in the great open spaces where men spend their time killing time instead of letting time kill them.

To get into proper trim for a campaign of intensive golf, he closed his desk one night for the last time, put on his coat, packed a bag or maybe two or three bags, and went off for a 90 day vacation which carried him to New York, Panama Canal and thence up the west coast to Alaska.

Oh! Yes, he came back again.

Now that he has seen all that is to be seen or perhaps more properly speaking, all that is worth seeing, he feels that he will be able to keep his eye on the ball.

According to all the great authorities, and many who are—well let us say—not quite so great, keeping the eye on the ball is a feat in the same class as noting under which shell the pea is hiding. Proficiency only is gained through long and careful practice.

Well authenticated cases are on record, it is claimed, where even long and careful practice has not been sufficient to locate either the pea or the ball.

Golf is an acquired taste which J. J. picked up between intensive campaigns of securing orders for vast quantities of steel castings. After the orders were secured he had to find ways and means of pushing them through the shop on schedule to meet the customers' requirements. Roughly speaking he spent 12 hours a day soliciting orders and producing the castings. The other 12 hours were devoted to buying materials, settling arguments, making promises, delivering the goods and collecting on them. The remainder of the day was his own to do with as he pleased and usually was spent in absolute idleness.

Of course the inevitable happened as it has been happening ever since what's-his-name gave us the famous lines about a certain character always finding something for idle hands to do. J. J.'s idle hands itched for something to do and the first thing he knew the certain character—referred to previously—slipped a golf club between the thumb and fingers of one hand.

His descent from that time was the same as that of any other golf bug. Time limitations, as previously noted, interfered to some extent with his practice. Even Bobby Jones would have difficulty in maintaining his form if he had to work 24 hours and had to confine his practice to the remainder of the day. He is good and all that, but even the best of men have their limits.

Now that J. J. no longer is engaged in trafficking in steel castings, now that the conditions have been reversed so that he can play for 24 hours a day and work for the remainder of the time, it is highly probable that Mr. Jones—yes, the very same Bobby Jones—will have to look to his laurels. Recent statistics compiled by the census board seem to indicate that retired foundrymen constitute the most virulent type of golf addict. Rarely spectacular, but persevering. That's the word, persevering.

Mr. Bever was born in Germany, Aug. 6, 1862, eight years before France and Germany—in sporting parlance—went to the mat for the second or third time to decide who was who and what are you going to do about it?

A few years later, to be exact, in 1873, the future golfer then being 11 years of age and all quiet on the western front, the family emigrated to America as so many thousands have done before and since.

In 1883 he secured a position as shipping clerk in the plant of the Walker Mfg. Co., Cleveland, at that time one of the most prominent engineering firms in the country and a training school for many men who since have made names for themselves in the foundry and related fields.

A natural inclination for handling tools, particularly wood working tools, induced him to take up an apprenticeship course which included terms in the drawing office, patternshop, foundry and machine shop. Later he returned to the main office where he served in turn as accountant, office manager, purchasing agent and general auditor.

Passage of the Walker works into the hands of the Westinghouse people suggested to J. J. that if a change of ownership is beneficial to a plant, a change in employment might be equally salutary to an individual. The same individual being no other than himself, he made a careful survey of the industrial situation and decided that a move to the East side would prove of mutual benefit to that section of the city and to himself.

After 16 years' service with the Walker works he was placed in charge of foundry sales by the Otis Steel Co., on Aug. 1, 1899. Later he was appointed foundry manager for the company and remained in that capacity for approximately 30 years until his recent retirement.

Mr. Bever is a member of the American Foundrymen's association, the American Society of Mechanical Engineers, American Iron and Steel institute, Cleveland Engineering society and various public service and fraternal organizations. For many years he was active in the Cleveland Foundrymen's association and is a past president of that organization.

DAN M. AVEY
*Editor*

# The Shakeout

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PAT DWYER
*Engineering Editor*

EDWIN BREMER
*Metallurgical Editor*

CHARLES VICKERS
*Nonferrous Editor*

NORMAN F. HINDLE
*Assistant Editor*

## ¶ Past, Present and Future

SINCE the foundry industry has many ramifications that extend into practically every manufacturing field, it is not surprising that any changes in the business activities of those industries is reflected in the activities of the foundries. In many instances the castings supplied by the foundry do not enter directly into a particular finished product, but act in an intermediate capacity. An example of that phase is illustrated by the steel rolling mill industry where castings shape the finished product. In some other finished products, the castings not only assist in shaping part of the material, but also are vital parts of the finished product. That phase is depicted by the automobile industry where castings shape the sheets for the bodies, fenders, etc., assist in shaping the axles and crankshafts, and in addition castings are present as motors, pistons, transmission gear cases, differential housings, etc.

BECAUSE castings enter so largely into automobile production, it may be expected that any rise or fall in the number of automobiles shipped by the manufacturers shows immediately to the advantage or disadvantage of the foundry industry. During 1930, ample evidence of the latter condition was present. However, a few statistics are submitted to show the change between 1929 and 1930. According to the bureau of census 5,277,474 passenger vehicles, chassis and commercial vehicles valued at $3,405,584,864 were produced in 1929. While official figures for 1930 will not be available for some time, it is estimated that approximately 3,321,680 motor-driven vehicles will be produced. That is a loss of 37.1 per cent from the previous year. However, that is water over the dam, and the look upstream is more encouraging. Indications point to 1931 as a recovery year for the autombile industry with further advances in 1932, according to the best opinion.

## ¶ You Make a Guess

WITH all of the knowledge made available by the passing centuries, it still seems exceedingly difficult to predict with consistent accuracy the probable economic trend of industry. So much disagreement develops constantly among economists with reference to the future course of business, that the industrial leader must look to many sources of information before deciding upon a course of action. The New Year is bringing forth the usual flood of prognostications. Because many of the experts were optimistic in the late summer when considering business possibilities for September and the early fall, they seem unduly pessimistic now. Because the guess was wrong in September does not mean necessarily that it will be inaccurate in January. However, the night does not seem as dark as some believe.

## ¶ The Home Scrap

A RECENT report of the research bureau of the Institute of Scrap Iron and Steel, presented in the Dec. 15 issue of THE FOUNDRY, reveals the interesting information that 1,783,900 tons of iron and steel scrap was consumed during 1929 by the steel foundry industry to produce 1,583,040 tons of steel castings. The figures are based on results of a survey in which returns were received from companies representing 65 per cent of the total capacity of the industry. Anyone familiar with the steel foundry industry probably will feel that the tonnage of scrap reported consumed is rather high.

FURTHER study of the report of the institute shows that the scrap used may be divided into two classifications as follows: Purchased on the open market, 1,080,872 tons; home scrap 703,082 tons. Since the home scrap usually refers to gates, risers and defective castings, the use of that classification in securing the total tonnage of metal consumed is somewhat like pyramiding on the stock market, for both tonnage and profits can be shown only on paper. Home scrap represents a certain amount of metal, depending of course on the class of casting and the schedule of production, which is melted day after day and returned as gates, risers, etc. In other words, home scrap consists of equivalent metal melted over again each day. It was in the foundry at the beginning of the year and a residual amount was there as the year closed. Therefore, in determining the total amount of scrap consumed in the manufacture of steel castings, is it correct to consider the home scrap as a part of the grand total?

THE FOUNDRY believes that it would be nearer correct and perhaps fairer to the steel foundry industry to state that in 1929, 1,080,872 tons of scrap iron and steel was consumed in producing 1,583,040 tons of steel castings.

# Comings and Goings of Foundrymen

**Men of the Industry, Whose Activities Are Making Foundry History**

L. C. WILSON has been made assistant plants manager for the American Chain Co., Inc., York division, York, Pa. Mr. Wilson, formerly vice president, Federal Malleable Co., Milwaukee, left that organization in 1928 to become assistant to the president of the Interstate Iron & Steel Co., Chicago. His connection with the American Chain Co. represents a return to the foundry industry through his executive duties in relation to the foundry of that company. Mr. Wilson graduated from the Sheffield Scientic School of Yale University in 1907. Following a number of years in the sales department of Harbison-Walker Refractories Co., Pittsburgh, when he was in various offices of that firm, he joined the staff of the Chain Belt Co., Milwaukee, as assistant to the vice president and later general sales manager. He became connected with the Federal Malleable Co. as secretary, was later elected vice president and general manager. He served from 1926 to 1929 as a director of the American Foundrymen's association and is prominent in the work of various committees dealing with problems of the malleable iron branch of the industry.

R. W. Griswold, president, Griswold Mfg. Co., Erie, Pa., has been elected president of the board of education of that city. W. Clay Missimer, superintendent, Malleable Iron Co., was elected vice president.

J. M. Bonner, for a number of years manager, Eljer-California Co., Los Angeles, is now general manager, Whiting-Mead Co., Los Angeles. The foundry department of the company is located at 2260 East Vernon street, Los Angeles.

Charles T. Ray has been elected president of B. F. Avery & Sons, Louisville, Ky., manufacturers of agricultural implements, to fill the vacancy caused by the death of William Black. Mr. Ray formerly was vice president in charge of manufacturing and a director. He has been with the company for 32 years.

Henry L. Zimmerman, formerly connected with the Zimmerman Steel Co., Bettendorf, Ia., the Santa Fe railroad and the Bettendorf Co., Bettendorf, has been appointed foundry engineer by the Freyn Engineering Co., Chicago and will leave for the Union of Socialistic Soviet Republics, on the S. S. Bremen, Dec. 16, for Kuzentsk, Russia, where he will spend 2 years. Mr. Zimmerman was born in Davenport, Iowa, 51 years ago. He formerly was vice president and treasurer, Zimmerman Steel Co., Bettendorf. He resigned that position in 1919 to engage in engineering work. During the past year he has been associated with the Santa Fe railroad and the Bettendorf Co. Mr. Zimmerman is a McLain system graduate.

Walter F. Graham, formerly of the technical department, Ohio Brass Co., Mansfield, O., has resigned that position to become technical director, Caskey Brass & Bronze Works Inc., Philadelphia. Mr. Graham is a native of Philadelphia and was educated at Haverford school and Haverford college, Haverford, Pa., and Pennsylvania State college, State College, Pa. He was graduated from the latter institution with a B.S. degree in metallurgical engineering in 1914. Following his graduation, he worked for the Standard Bearing Co., Philadelphia, and the Ferro Machine & Foundry Co., Cleveland. Later he accepted a position as metallurgist with the Ingersoll-Rand Co., at Athens and Painted Post, N. Y. During the war, he served as a lieutenant in the ordnance department. At the end of the war, he became connected with the Spicer Mfg. Co., South Plainfield, N. J. and later served with the Henry Souther Engineering Co., Hartford, Conn., Curtis Bay Copper & Iron Works, Baltimore, and the American Mond Nickel Co., Pittsburgh. Mr. Graham resigned the latter position to become affiliated with the Ohio Brass Co., Mansfield, O., in the technical department. He is a member of the American Foundrymen's association, American Institute of Mechanical Engineers, Society of Automotive Engineers, British Institute of Metals, American Society of Testing Materials, American Society for Steel Treating and other technical organizations.

**Walter F. Graham**

C. R. Messinger, president, Chain Belt Co., Milwaukee, will become president of the Oliver Farm Equipment Co., according to an announcement made by Joseph D. Oliver, chairman of the board of the latter company. M. W. Ellis, who has been president of the company since its organization, becomes vice chairman of the board. Mr. Messinger and W. C. Frye, of Milwaukee, were elected directors.

Robert S. Archer, formerly connected with the Aluminum Co. of America and the Aluminum Castings Co., Cleveland, as research metallurgist, has resigned that position to become director of metallurgy for the A. O. Smith Corp., Milwaukee. Mr. Archer received his early education at Cass Technical high school, Detroit, and received his B.S. and M.S. degrees from the University of Michigan from which he was graduated in 1916. Following graduation, he became research engineer, Detroit Edison Co., and in 1918 served as research metallurgist, bureau of aircraft production. The following year he became connected with the Aluminum Co. of America as research chemist a position he held until his recent change. Mr. Archer is well known for his contributions to the technical press and for his book "Science of Metals" published in collaboration with Dr. Zay Jeffries. He is a member of the American Institute of Mining and Metallurgical Engineers, American Society of Testing Materials, British Institute of Metals, American Society for Steel Treating, Cleveland Engineering society and many other social and technical organizations.

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The magnetic properties of iron-chromium alloys containing 10 to 20 per cent chromium, and 17.5 per cent chromium and 0 to 10 per cent nickel have been investigated and the results published in a bulletin entitled "An Investigation of the Magnetic and Electrical Properties of Some Chromium Alloys," by K. F. Fischer. The bulletin may be obtained from the Rensselaer Polytechnic institute, Troy, N. Y.

## St. Louis Foundrymen Hold Meeting

The regular monthly meeting of the St. Louis District Foundrymen's club was held Dec. 4 at the American Annex hotel, St. Louis. H. R. Culling, Carondelet Foundry Co., St. Louis, president of the club, acted as chairman. The meeting was addressed by M. F. Pendergast, Whiting Corp., Harvey, Ill., who spoke on "Trouble Shooting and the Cupola." Mr. Pendergast has had a wide experience in various parts of the United States and part of his talk delt with some of the weird theories advanced for cupola operation.

Among the many subjects discussed were the oldest and the oldest cupola practices that he had encountered and a discussion of continuous foundry practice. The speaker emphasized the fact that more knowledge is required to operate a cupola continuously during the entire day than for 2 hours or less. Gaging the melting speed to meet a variable molding rate requires good management and supervision. Difficulty also is encountered in educating the cupola tender, accustomed to short time cupola melting, in the operation of that type furnace continuously.

Other subjects relating to cupola operation discussed by Mr. Pendergast include blowers and blower equipment, piping, elbows, height of stacks, patching, charging, lighting, height of bed, size of charges, iron to coke ratios, tap hole, slagging, fluxing and management. The speaker also discussed tuyeres and said that he was in favor of two sets. A lively discussion followed the address.

Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis, secretary-treasurer of the club, urged all members to make themselves a part of the membership committee and to use their efforts to build up the club. On being informed of the death of Dr. R. Moldenke, the club payed a fitting tribute.

## Secures Gas Division of Columbus Company

Surface Combustion Co., Toledo, O., recently acquired the gas equipment division, Columbus Heating & Ventilating Co., Columbus. The acquisition also includes the foundry division of the latter company. Manufacturing activities of the Columbus company will be maintained at Columbus for the present but sales activities will be consolidated with the selling organization of the Surface Combustion Co. It also is anticipated that the present line of Columbus gas-fired furnaces will be augmented with various styles, sizes and price ranges. Surface Combustion Co. recently acquired Chapman-Stein Co., Mt. Vernon, O.

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Cleveland Pneumatic Tool Co., Cleveland, has moved its Philadelphia office from the Bourse building to the seventh floor, Terminal Commerce building, 401 North Broad street, Philadelphia.

# Foundry Association Directory

**American Foundrymen's Association**

President, N. K. B. Patch, Lumen Bearing Co., Buffalo; executive secretary-treasurer, C. E. Hoyt, 222 West Adams street, Chicago; technical secretary, R. E. Kennedy, 222 West Adams street, Chicago. Annual meeting, Stevens hotel, Chicago, May 4-7, 1931.

**Associated Brass Founders of New England**

President, George W. Thornburg, Crescent Park Brass Foundry, Waltham, Mass.; secretary, R. B. Bonner, Somerville Machine & Foundry Co., 14 Kent street, Somerville, Mass. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

**The Buffalo Foundrymen**

President, J. McArthur, Washington Iron Works; secretary, W. J. Wark, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

**Central Illinois Foundrymen's Club**

President, H. M. Hire, Hire Foundry Co., Peoria, Ill.; secretary, Franklin Whitehead, The Meadows Mfg. Co., Bloomington, Ill.

**Chicago Foundrymen's Club**

Presiden,t L. E. Gilmore, Crane Co., Chicago; secretary, Albert N. Wallin, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

**Connecticut Foundrymen's Association**

President, Carl S. Neumann, Union Mfg. Co., New Britain, Conn.; secretary, Charles S. Parker, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

**Detroit Foundrymen's Association**

President, James L. Mahon, American Car & Foundry Co.; secretary, William J. Muhlitner, Great Lakes Foundry Sand Co., 2100 Penobscot building, Detroit. Meetings third Thursday in each month, except December, June, July and August at Ft. Shelby Hotel.

**East Bay Foundrymen's Association**

Secretary, O. R. Moller, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

**Electric Steel Founders' Research Group**

Director, R. A. Bull, Assistant Director, C. N. Ring; Central Office, 541 Diversey Parkway, Chicago.

**Gray Iron Institute**

President, B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J.; manager, Arthur J. Tuscany, Terminal Tower building, Cleveland.

**Malleable Iron Research Institute**

President, R. R. Fauntleroy, Moline Malleable Iron Co., St. Charles, Ill.; secretary, Robert E. Belt, Union Trust building, Cleveland.

**Metropolitan Brass Founders' Association**

President, William Ember, Jeffersor Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, William E. Paulson, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue.

**Newark Foundrymen's Association**

President, W. H. Mantz Atlas Foundry Co., Irvington, N. J.; secretary, G. W. Hannay, Barnett Foundry & Machine Co., Irvington, N. J. Meeting called by president. Scheduled meeting dates: Dec. 3; Jan. 28; March 25; May 27.

**New England Foundrymen's Association**

President, Ernest F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass.; secretary Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass. Meetings held the second Wednesday of each month. Outings usually are held in the summer months.

**Ohio Foundries Association Inc.**

President, A. H. Kramer, Advance Foundry Co., Dayton, O.; secretary, Robert Hoierman, 418 Penton building, Cleveland. Annual meeting Nov. 13 at Columbus, O.

**Pacific Coast Founders Association**

President, Charles J. P. Hoehn, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. Truitt, 55 New Montgomery street, San Francisco.

**Philadelphia Foundrymen's Association**

President, C. F. Hopkins, Ajax Metal Co., Philadelphia; secretary, Earl Sparks, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

**Pittsburgh Foundrymen's Association**

President, W. E. Troutman, Duquesne Steel Foundry Co., Pittsburgh; secretary-treasurer, William J. Brant, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August at Fort Pitt hotel.

**Quad City Foundrymen's Association**

President, R. L. Eichman, Bettendorf Co., Bettendorf, Ia.; secretary-treasurer, Stanley Brah. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

**St. Louis District Foundrymen's Club**

President, Horace R. Culling, Carondelet Foundry Co., St. Louis; secretary-treasurer, Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis. Meetings the fourth Thursday of the month at 6:30 p. m., at the American Annex hotel, Sixth and Market streets, St. Louis.

**Southern Metal Trades Association**

President, John S. Schofield, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. Dunn Jr., Flatiron building, Atlanta, Ga.

**Steel Castings Development Bureau**

Research Director, George Batty, 500 Stock Exchange building, Philadelphia.

**Steel Founders' Society of America**

President, J. E. McCauley, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.; managing director, G. P. Rogers, Graybar building, New York.

**Tri-City Technical Council**

Chairman, C. F. Scherer, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. Xander, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

**Tri-State Foundrymen's Association**

President, William Hoppenjanz, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. Erhart, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

**Twin City Foundrymen's Association**

President, William J. Snyker, St. Paul Foundry Co., St. Paul; secretary-treasurer, C. E. Langdon, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

**Washington Foundrymen's Club**

President, J. W. Orphan, Lake Union Foundry Co., 1703 Westlake avenue, Seattle; secretary, Edward C. Gustin, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

**Western Foundrymen's Association**

President, H. T. Hornsby, Joplin, Mo.; secretary, E. L. Graham, Acme Foundry & Machine Co., Coffeyville, Kans.

**Wisconsin Gray Iron Foundry Group**

Secretary, W. F. Bornfleth, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on second Wednesday of each month at Hotel Schroeder, Milwaukee.

# Trade Trends in Tabloid

INDUSTRIAL activity during first part of December changed little over November's rate. Foundry operations generally are holding with slight gains noted here and there.

—T—T—

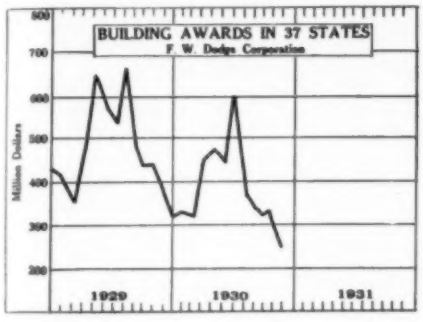
Unfilled orders of the United States Steel Corp. on Nov. 30 gained 4.5 per cent over the Oct. 31 total.

—T—T—

Index of machine tool orders for November dropped to the low point in six years.

—T—T—

Around Chicago, foundry operations remained at about 40 per cent at mid-month. Several jobbing shops, specializing chiefly in light work, have increased activity, a few pouring five or six days a week. Steel




foundry activity is up and down; orders on hand by brass foundries have increased, although operations remain about the same, and aluminum shops are down slightly.

—T—T—

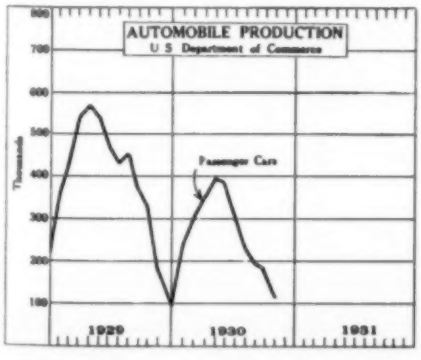
New orders for hoists increased 3.73 per cent in November over the previous month, according to a report of the Electric Hoist Manufacturers association.

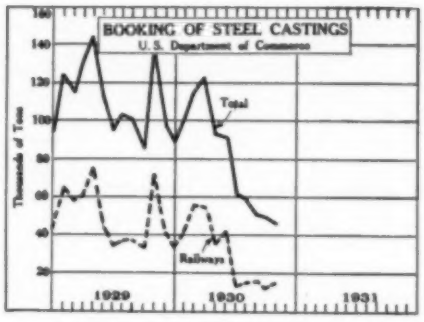
—T—T—

Atchison, Topeka & Santa Fe has placed orders for 1522 freight cars, reducing the number of cars on active inquiry to approximately 1000, of which 800 are for Chicago & Illinois Midland.

—T—T—

With Milwaukee seeking 6000 tons




and Detroit 11,000 tons, municipal interest in cast iron pipe is looking up. Birmingham pipe foundries generally closed down the last ten days of December.

—T—T—

Unfilled orders for brass and bronze ingots and billets on books of members of Non-Ferrous Ingot Metal Institute totaled 27,221 tons on Dec. 1, a gain over the 24,723 ton total on Nov. 1.

—T—T—

Building awards found a new low in November with a loss of 25 per cent compared with October. November totaled $253,573,700, October $337,301,400 and November, 1929, $381,012,500.

—T—T—

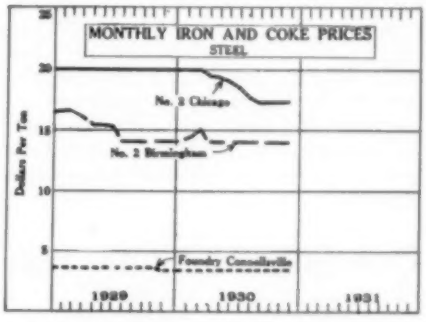
Automobile production schedules stepped up slightly the first of December, only to fall again later in the month, leaving the month's total about equal to November, estimated at 124,000 cars and trucks. However, Detroit seems more optimistic as numerous makers, such as Chevrolet, Oldsmobile, Willys, Oakland-Pontiac and Hudson-Essex work on improved schedules.

—T—T—

Steel mill operations dropped slightly to 38 per cent the third week of December. Chicago, Birmingham and Youngstown mills averaged 40 per cent, Pittsburgh and Eastern Pennsylvania 38, Cleveland 48 and Buffalo 24.

—T—T—

After declining steadily through November, freight car loadings staged a comeback for the week ended Dec. 9. Total for that week




was 787,173 cars, or 85,088 cars in excess of the previous week. Total loadings for 1930 were lowest since 1922.

—T—T—

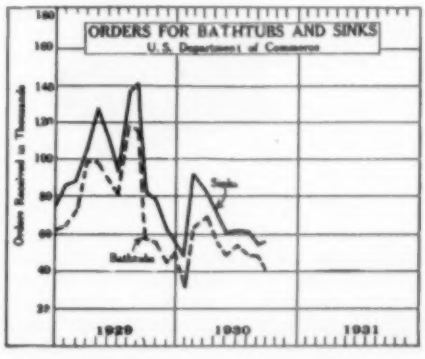
Westinghouse believes that sometime during 1931, there is every reason to expect a general improvement. Because of great diversity of product, that company reports it felt the 1930 depression less keenly than many industries.

—T—T—

Numerous prognosticators, with their minds centered on bad guesses last September, seem unduly pessimistic over business in the immediate future. Reports from industry and general sentiment indicate the experts again may be wrong.

**RAW MATERIAL PRICES**
**December 18, 1930**

| | |
|---|---|
| **Iron** | |
| No. 2 foundry, Valley | $17.00 |
| No. 2 Southern, Birmingham | 14.00 |
| No. 2 foundry, Chicago | 17.50 |
| No. 2 foundry, Buffalo | 17.50 |
| Basic, Valley | 17.00 |
| Basic, Buffalo | 17.00 |
| Malleable, Chicago | 17.50 |
| Malleable, Buffalo | 18.00 |
| **Coke** | |
| Connellsville beehive coke | $3.50 to 4.85 |
| Wise county beehive coke | 4.25 to 5.00 |
| Detroit by-product coke | 8.50 |
| **Scrap** | |
| Heavy melting steel, Valley | $12.00 to 12.50 |
| Heavy melting steel, Pitts | 12.50 to 13.00 |
| Heavy melting steel, Chicago | 10.00 to 10.50 |
| Stove plate, Buffalo | 9.00 to 9.25 |
| Stove plate, Chicago | 6.50 to 7.00 |
| No. 1 cast, New York | 8.00 to 8.50 |
| No. 1 cast, Chicago | 9.50 to 10.00 |
| No. 1 cast, Philadelphia | 12.50 to 13.00 |
| No. 1 cast, Pittsburgh | 12.50 to 13.00 |
| No. 1 cast, Birmingham | 11.50 to 12.00 |
| Car wheels, iron, Pittsburgh | 13.50 to 14.00 |
| Car wheels, iron, Chicago | 11.50 to 12.00 |
| Railroad malleable, Chicago | 12.00 to 12.50 |
| Agricultural mal., Chicago | 11.00 to 11.50 |
| Malleable, Buffalo | 13.00 to 13.50 |
| **Nonferrous Metals** | **Cents per pound** |
| Casting, copper, refinery | 9.87½ |
| Straits, tin | 24.00 |
| Aluminum, No. 12, producers | 22.00 |
| Aluminum, No. 12 remelt | 12.50 |
| Lead, New York | 5.10 |
| Antimony, New York | 7.00 to 7.10 |
| Nickel, electro | 35.00 |
| Zinc, East St. Louis, Ill. | 4.00 |



## Goggle Is Made To Fit Over Spectacles

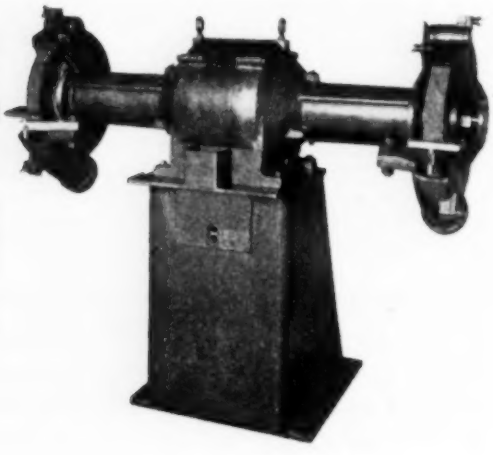
Willson Products Inc., Reading, Pa., recently has placed upon the market a new type goggle which may be worn over corrective spectacles. One style is made especially for chippers, grinders, etc., and is equipped with hardened lenses. The new goggle is light weight but strong, is well ventilated and is equipped with unground lenses. It is claimed that the new goggle eliminates the necessity of grinding special lenses for workmen

*Specially Ground Lenses Are Unnecessary With New Type Goggle*

with defective eye sight, that toughness of the lenses is not sacrificed or damaged by grinding, that the goggle is more comfortable, and that less eye strain results because of improper lenses.

## Grinding Machine Has Extended Spindles

Production Equipment Co., Cleveland, has introduced a new, heavy duty type, extended spindle, grinding machine equipped with a totally enclosed motor, ball bearings and extra heavy nickel steel spindles. The motor requires no ventilation and is built by the company. It operates within the American In-



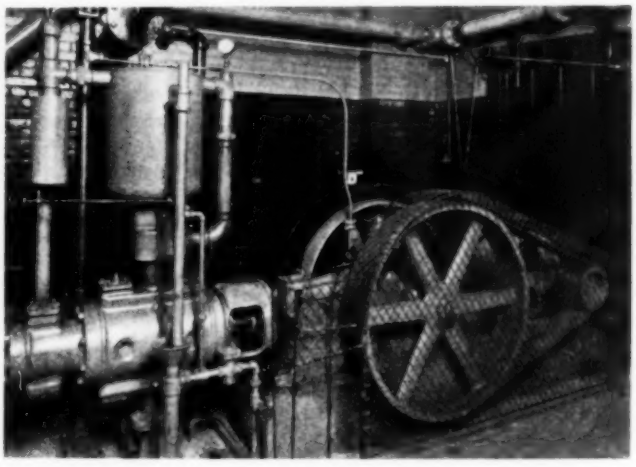
*The Unit Is Equipped with Four Heavy Duty Ball Bearings*

stitute of Electrical Engineers temperature limitations. Four heavy duty ball bearings, two in each extended arm, provide easy operation.

The company also is manufacturing motorized speed reducer with capacities up to 20 horsepower. Units consist of a standard, heavy duty, electric motor and an integral, planetary gear reduction mounted in an oil-tight housing. Motors are built by the company and can be supplied in single speed, multispeed, enclosed and tigh torque designs for horizontal or vertical mounting. Reducers provide a straight line drive with final speeds ranging from 50 to 550 revolutions per minute.

## Compressor Designed To Conserve Floor Space

Pennsylvania Pump & Compressor Co., Easton, Pa., has introduced a new type two-stage, tandem, air compressor suitable for pressures up to 250 pounds per square inch. The apparatus was designed to provide a compressor which would meet requirements of two-stage tandem service within range of its capacity but would be more economical of floor space than the standard type. The feature of the unit is that the high pressure cylinder is single acting instead of double acting. The high pressure cylinder is attached directly to the low pressure cylinder without any distance between the two. A plunger at the end of the piston acts as the piston for the high pressure cylinder and compresses the air at one stroke of the piston rod. That construction, when combined with an overload type motor mounting for multiple belt drive, makes a compact unit.



*The High Pressure Cylinder Is Single Instead of Double Acting*

## Scullin Addresses Gray Iron Foundry Group

Sixty-five members of the Wisconsin Gray Iron Foundry group met at the Hotel Schroeder, Milwaukee, Dec. 10, to hear an address by C. J. Scullin, Mississippi Valley Research Laboratories, St. Louis, on "The Cupola in the Gray Iron Foundry." Mr. Scullin discussed various phases of cupola practice and considerable interest and discussion resulted from his remarks on the front slagging type furnace.

Two bulletins, representing the work of the sand committee of the group during the past month, were submitted to the members. The report contained information comparing the sands in use among the member foundries with possible sources within the state. The classification was based on the A. F. A. standards of grain fineness and clay content. The group also voted to accept the pattern standards as advanced by the A. F. A. and approved by the department of commerce. The secretary was instructed to notify the department of this action.

## Activities of Technical Department Outlined

Gray Iron Institute, Terminal Tower building, Cleveland, describes in a recent bulletin the objectives of the newly formed technical department which is under the direction of Oliver Smalley, technical director. Those include the elevation of the standards of gray cast iron; advice on specifications; collaboration with technical societies and committees and keeping the members informed

on progress and development; testing bars submitted by members of the institute and reporting results in a bulletin; establish specifications which will identify the properties of a casting and will classify gray iron suitably, differentiating between ornamental, general construction, high test, wear, toughness, corrosion resistance, heat resisting and such other properties as necessary; organization of a cousulting and information department; issue research and instruction bulletins; exchange information with various technical and foundry institutions; arrange for lectures, articles, etc., on gray iron; and to broaden present uses of gray iron and develop new uses.

## OBITUARY

W. C. Coulter, president and general manager Coulter Copper & Brass Co., Ltd., Toronto, Ont., died Nov. 25.

Samuel F. Long, 57 years old, for the past ten years affiliated with the National Roll & Foundry Co., Avonmore, Pa., died in Pittsburgh, Dec. 4. Mr. Long at one time was associated with Julian Kennedy, steel plant engineer in Pittsburgh, and later was connected with the Mesta Machine Co., Pittsburgh. In 1912 he became president of the Ironclad Mfg. Co., Canton, O., and eight years later joined the sales department, National Roll & Foundry Co., maintaining his headquarters in Canton.

Walter Ross Gravener, 59 years old, southeastern sales manager for American Steel Foundries, Chicago, since November, 1929, died recently.

Harry W. Workman, 46 years old, president and manager, Lima Metals Foundry Co., Lima, O., died Dec. 2 at Chicago. He located in Lima in 1914 following his graduation from the University of Michigan, Ann Arbor, Mich.

Claude M. Dibble, 40, vice president in charge of production, Moore Bros. Co., Joliet, Ill., manufacturer of stoves and domestic heating equipment, died Dec. 14 at a hospital in Evanston, Ill., following a short illness. He was a graduate in engineering of the Sheffield Scientific school, Yale university, and had specialized in the design of stoves, furnaces and heating apparatus. He also was buyer for the Moore Bros. Co.

Randolph Ortman, 66 years old, formerly president and later chairman of the board of directors, American Manganese Steel Co., Chicago Heights, Ill., died Dec. 8 in the University hospital, Charlottesville, Va. He was born in Vienna but received his education at Detroit and Saginaw, Mich. From 1893 until 1915 he was assistant treasurer of Griffin Wheel Co., Chicago. He had been president and then chairman of the Ramapo-Ajax Corp., Hilburn, N. Y. He was a director of American Brake Shoe & Foundry Co., New York, and American Forge Co., San Francisco.

Fred Graf, for the past two years connected with the Milwaukee Foundry Equipment Co., Milwaukee, died Dec. 4, following an illness of eight months. He was 40 years old. Following graduation from Purdue university, Lafayette, Ind., he was employed by the Commonwealth Steel Co., Granite City, Ill., now a division of the General Steel Castings Corp., and later was connected with the Southern Wheel Co., Pittsburgh, as foundry engineer. He resigned that position to take charge of the foundry engineering department, Frank D. Chase Inc., Chicago. In 1925 he was appointed vice president in charge of production, development and engineering, American Foundry Equipment Co., Mishawaka, Ind., and in 1928 became connected with the Milwaukee company.

# What the Foundries Are Doing

**Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops**

J. & B. Foundry Co. Inc., Taladega, Ala., has discontinued its foundry business.

The new foundry of the Benton Harbor Malleable Industries, Benton Harbor, Mich., will be finished shortly.

American Radiator Co. plant at Litchfield, Ill., will employ 500 men on a 5-day schedule beginning Jan. 1.

Eureka Foundry & Pattern Co. Inc., 2601 East Twenty-sixth street, Los Angeles, has discontinued operations.

Reliance Iron Works, 1000 South Meridian street, Alhambra, Calif., is building a 60-foot extension to its foundry.

Fellows Brass & Iron Foundry, Fellsway and Myrtle streets, Medford, Boston, has been acquired by L. S. Smith and W. F. Corson.

Niagara Brass Works, 3615 Orchard street, Niagara Falls, Ont., recently began operations. E. Lawson is owner and manager.

Salem Bronze & Aluminum Co., 56 Jefferson avenue, Salem, Mass., has been organized by J. T. Gene and James Laurie.

Acme Castings Co., Birmingham, Ala., which was organized several months ago, is being operated by Walter H. Miller and James Malcolm, owners.

Norway Mfg. Co., York, Pa., has been incorporated with $100,000 capital by William H. Stough, 933 North Duke street, treasurer. The new company will manufacture and deal in electrical and mechanical appliances and equipment, castings, tools and specialties.

East Birmingham Bronze & Foundry Co., Birmingham, Ala., has been organized and placed in operation. J. B. Lankford is owner.

The foundry of the Eureka Brass Works, 1040 Humbert avenue, Cincinnati, O., has been sold to the Young & Bertke Co.

Gratiot Foundry Co. is preparing for operation in Imlay City, Mich. The company will manufacture brass and bronze castings. (Noted Dec. 15.)

Economy Street Marker Co., Littlefield building, Austin, Tex., requires information on die casting machines to be used for the production of ¼, ½ and ¾-pound aluminum alloy castings.

Ohio Steel Foundry Co., Lima, O., has received orders for 250 tons of steel castings from the Pennsylvania railroad for use in the erection of freight cars at the latter company's Altoona, Pa., shops.

Charlotte Pipe & Foundry Co., Charlotte, N. C., has awarded a contract to the Ingalls Iron Works, 720 Fourth avenue, Birmingham, Ala., for the structural steel for rebuilding the plant which recently was burned. (Noted Dec. 1.)

Malleable Iron division, General Motors Corp., Saginaw, Mich., has let the contract for a 68 x 512 foot extension to its foundry which will house the annealing department. The shop now is reported to be working 10 hours per day, 6 days per week.

T. Tomlinson Foundry Co., Ltd., Toronto, Ont., has moved its foundry from 9 Frederick street to Church and Esplanade streets. The new premises will increase capacity by approximately 200 per cent. No equipment will be required.

J. C. Haimer and F. F. Koehler, Waukesha, Wis., formerly associated with the Glancy Malleable Corp., Waukesha, have purchased a plant at Baraboo, Wis., formerly used as a round house and will operate it for the production of gray iron and aluminum castings.

Whessoe Foundry & Engineering Co., Ltd., Darlington, England, has been appointed exclusive manufacturing agent in Great Britain, including England, Scotland, Wales and Ireland, for the manufacture of oil refinery and blast furnace equipment designed by the Arthur G. McKee & Co., Cleveland.

Kennedy Pattern Works, Anniston, Ala., has changed its name to Kennedy Pattern & Foundry Co. and has moved into larger quarters on Front street. The company will produce gray iron in addition to its regular line of brass

and bronze castings. K. E. Kennedy is manager and owner.

The plant of the Mid-West Foundry Co., 200 Larimer street, Denver, Colo., recently was damaged slightly by fire.

Chelsea Foundry & Mfg. Co. Inc., Chelsea, Mich., has been incorporated with $50,000 capital for the manufacture of gray iron and steel castings.

Notices of corporate changes filed at Dover, Del., include a capital increase from $100,000 to $500,000 by the General Bronze Co., Pittsburgh.

Maryland Foundry Co., 423 Calvert building, Baltimore, has been incorporated by Charles F. Goldberg to operate a foundry.

A. Kilpatrick & Sons Foundry Co., Carrie and Bulwer avenues, St. Louis, recently sustained a $20,000 fire damage to its plant. The loss was due principally to pattern damage.

Bruce Pebbles, Canada Ltd., Montreal, Que., has been incorporated with $50,000 capital by S. G. Dixon, 132 St. James street, to carry on the business of engineer brass and iron founder.

Century Electric Co., St. Louis, is erecting additions to its foundry, 41 x 287 and 43 x 49 feet, containing approximately 16,000 square feet. The addition with equipment will represent an investment of about $50,000.

Construction of the steel foundry being erected by the Carroll Steel Foundry Co., Houghton, Mich., has been stopped for the winter. Work will be resumed early in the spring. (Noted Nov. 1.)

Cox Ferrous Metal Foundry, 609 Auburn avenue, Pontiac, Mich., has begun production and is specializing in the manufacture of copper, brass and aluminum castings. R. B. Cox is owner and George Dixon is manager.

Johnson Machine Co., Clearfield, Pa., has been incorporated with $25,000 capital by Clair Ogden, treasurer, to conduct a foundry and machine shop. The new company will manufacture and repair hardware and brick plant machinery and industrial equipment.

Western Gas Construction Co., 1429 Buchanan street, Fort Wayne, Ind., recently completed an addition to its foundry. The new addition is 70 x 42 feet and houses a heating plant, core room equipment, and added molding space.

Bendix Foundry Corp., 2300 Bloomingdale avenue, Chicago, has been incorporated with $120,000 capital to carry on a general foundry and machine shop business. B. I. Bendixen, T. L. Arzt and Harry Okin are the incorporators.

C. M. Grey Mfg. Co., 358 Central avenue, East Orange, N. J., will build a 2-story die casting plant on Shepard avenue near Central avenue. Preliminary plans now are being made. The new construction is estimated to cost $40,000.

Chrome Alloys Mfg. Co., Oakland, Calif., has acquired 2400 square feet of floor space at Dennison and King streets. The company is engaged in foundry business, manufacturing marine hardware, valves, canning machinery and metal novelties. H. McFadden is shop manager.

The following Toledo, O., foundries are among those firms which will expand during 1931: Binney Castings Co., 1801 Clinton street, will build an addition and probably a new plant; Baer Pattern & Castings Co., 2465 Albion street; Belmont Foundry, 1213 Belmont avenue; Bunting Brass and Bronze Co., 715 Spencer street; and Burt Foundry Co., Bush and Wheeling & Lake Erie railroad. That information recently was released by the industrial department, chamber of commerce, Toledo, O., Robert J. Eustace, industrial commissioner.

Oliver Farm Equipment Co. has resumed full operations at its Battle Creek, Mich., plant. This follows full operations started a week ago at the company's Hart-Parr tractor plant, Charles City, Iowa. Operations at the South Bend, Ind., and Springfield, O., plants continue on a modified scale.

Bosshardt Steel Corp., Allen avenue, southeast, Canton, O., is taking bids for the building of furnaces and installation of machinery. Operations will start March 1 with two furnaces and later 12 will be required. The company will produce steel castings using a special process. Walter J. Willis is vice president in charge of operations. (Noted Nov. 1.)

Sterling Range & Furnace Co., 524 Oak street, Rochester, N. Y., and Fuller & Warren Co., Monroe and River streets, Troy, N. Y., have been merged under the name of the Sterling-Stewart Corp., Rochester, N. Y. Beginning Jan. 1, all manufacturing operations will be done at the Rochester plant and a complete warehouse stock will be maintained at Troy.

Allis-Chalmers Mfg. Co., Milwaukee, has booked two orders for sugar cane harvesting machines amounting to approximately $350,000. Fourteen machines are to be built for the Southern Sugar Co. of Florida and six for the Punte Alegre Co. of Cuba. The machines are constructed on designs by the sugar concerns, and if successful, it is expected that a regular production schedule can be instituted in the Milwaukee works.

Buckeye Foundry Co., 2257 Buck street, Cincinnati, advises through R. J. Redmond, secretary, that a contract has been awarded to D. Mainken Sons Co., 2143 Bernard street, for a 1-story foundry, 120 x 280 feet, with center bay 35 x 50 feet, and two other bays 35 x 35 feet. Contract also includes a 3-story pattern storage and office building 50 x 140 feet. The new plant will be ready for occupancy next spring. (Noted December 15.)

# New Trade Publications

DIE CASTINGS—A booklet by the New Jersey Zinc Co., New York, calls attention to the use of alloyed zinc for die castings. Illustrations show a variety of articles and machine parts produced by this means.

LIFT TRUCKS—A new lift truck developed by the Revolvator Co., Jersey City, N. J., is described in a bulletin now being distributed. Illustrations show the truck and details of construction and tables show specifications.

FURNACES—George J. Hagan Co., Pittsburgh, has published several bulletins describing types of furnaces covering car-type, rotary open-hearth, box-type, pusher-type and apron conveyor-type. Each describes the special uses to which the furnace may be put.

TRAMRAIL—Handling of automotive industry loads overhead, with safety, is the subject of a bulletin by the Cleveland Electric Tramrail division of the Cleveland Crane & Engineering Co., Wickliffe, O. Illustrations stress the safety features.

FLOOR TRUCKS—A wide variety of floor trucks and material handling equipment is illustrated and described in a bulletin issued by Lewis-Shepard Co., Watertown Station, Boston. Trucks for most industrial uses are included in the catalog of products made by the company.

MATERIALS HANDLING—Economical material handling is the subject of a booklet published by the Louden Machinery Co., Fairfield, Iowa. It pictures installations of conveying equipment, analyzes problems of material handling and discusses methods and equipment.

BENTONITE—Bulletin No. 107 of the Silica Products Co., 700 Baltimore avenue, Kansas City, Mo., describes the properties of bentonite, a natural, hydrous, silicate of alumina which forms a viscous gel in the presence of water. Among the various uses suggested by the company, the product is indicated as a binder for silica sand for making foundry molds and cores or as a core wash.

GASOLINE LOCOMOTIVES—Brookville Locomotive Co., Brookville, Pa., is distributing a bulletin illustrating and describing the industrial locomotives, powered by the Ford motor, which are made by the company. Features of design and illustrations of typical uses are included.

SYNCHRONOUS MOTORS — Low-speed synchronous motors for direct connection to reciprocating compressors are described in a bulletin issued by the General Electric Co., Schenectady, N. Y. Bulletin GEA-132 from the same company is devoted to phase protective panels for polyphase motors.

COMPRESSORS — Pennsylvania Pump & Compressor Co., Easton, Pa., has issued illustrated bulletins No. 153 and 151, describing respectively two-stage air compressors and duplex air and gas compressors. Features of design are covered and engineering data covering installation and uses are given.

ELECTRICAL HEATING—Industrial, electric heating equipment forms the subject of a catalog of the Westinghouse Electric & Mfg. Co., industrial heating division, Mansfield, O. It contains a list of definitions, applications of furnaces, determination of sizes and descriptions of the various units of heating equipment.

INDUSTRIAL RAILWAYS — Illustrations in leaflet No. 101, issued by the American Car & Foundry Co., 30 Church street, New York, give a brief, pictorial summary of the line of industrial railway equipment produced by the company. The equipment is adapted to many applications including mines, quarries, contracting operations, and manufacturing plants.